NUS
CORPORATION

1927 LAKESIDE PARKWAY
SUITE 614
TUCKER, GEORGIA 30084
404-938-7710

24676

C-586-12-7-95

December 18, 1987

Mr. Robert Jourdan
Site Investigation & Support Branch
Waste Management Division
Environmental Protection Agency
345 Courtland St. N.E.
Atlanta Georgia 30365

Subject: Preliminary Assessment
Plant Site
Summerville, South Carolina
TDD#: F4-8709-39
EPA ID #: SCD061525192

Dear Mr. Jourdan:

Enclosed please find two (2) copies of the revised Preliminary Assessment with four mile radius map for the above referenced site.

If you have any questions, please contact me at NUS Corporation.

Very truly yours,

Carol D. Northern

Carol D. Northern
Geologist

Approved:

Connie Ostrofsky

CN/mb

Enclosure (2)

cc: Scott Gardner

PLANT SITE
SCD061525192
PRELIMINARY ASSESSMENT

A. **Site Description:** The Plant Site is located on Highway 78W, Summerville, Dorchester County, South Carolina [1] (Figure 1).

B. **Description of Hazardous Conditions, Incidents and Permit Violations**: The Plant Site consists of 25,000 pounds of yarn buried at the site on a one time basis. The yarn had trace amounts of mercury and cadmium [1].

C. **Nature of Hazardous Materials**: Cadmium affects the lungs and kidneys (2). Mercury has an adverse effect on the central nervous system [2].

D. **Routes of Contamination**: Since wastes were buried, there is a potential for groundwater contamination.

E. **Possible Affected Population and Resources:** In the Summerville area, the surficial aquifer is less than 30 feet thick. The surficial aquifer is underlain by the Cooper Marl, which is 170 feet thick in this area. The Cooper Marl is extremely impermeable. Only a few feet of this formation need be present to effectively retard the vertical movement of groundwater [4]. The Cooper Marl is underlain by at least five aquifers of varying productivity [4].

The thin surficial aquifer produces very little water in the Summerville area. Wells must be drilled through the impermeable Cooper Marl to encounter producible amounts of groundwater for domestic use (4).

The City of Summerville uses a mix of surface water (from their own treatment plant and water bought from Charleston) and groundwater. The majority of their water comes from their own wells [3,4,5]. Summerville has five wells located throughout the city. These wells average 1,840 feet in depth [3,5]. The Summerville wells produce from the sand layers of the Middendorf and Black Creek formations. The screened internal for these wells is between 1,600 and 1,700 feet [4].

Information concerning the exact location of these wells is unavailable.

F. **Recommendations and Justification**: Since the buried yarn contained only trace amounts of contaminants, and the aquifers used in the area are overlain by an impermeable Marl 170 feet thick, a priority for site investigation of none is recommended [1,4].

References

1. USEPA Potential Hazardous Waste Site Identification and Preliminary Assessment for Plant Site, Summerville, Dorchester County, South Carolina. 3/31/81.

2. Kirk-Othmer. 1981. Encyclopedia of Chemical Technology. John Wiley & Sons, N.Y. pp. 264-270.

3. Doran, C. to File, 9/14/87. Conversation record with Mr. Reynolds about the water system of Summerville, South Carolina.

4. Park, A. 1985. The Ground-Water Resources of Charleston, Berkeley, and Dorchester Counties, South Carolina. State of South Carolina Water Resources Commission Report No. 139. 145 p.

5. Doran, C. to File, 9/23/87. Conversation record with Mr. Wilkins about the water system of Summerville, South Carolina.

SITE DISCOVERY FORM

Part 1: Information necessary to add a site to CERCLIS

ACTION: A

EPA ID: SCD061525192

SITE NAME: Plant Site (Exxon Chemical Company) SOURCE: R (R=EPA, T=STATE

STREET: Highway 78 W CONG DIST: 01 (optional)

CITY: Summerville ZIP: 29483 - ____

CNTY NAME: Dorchester CNTY CODE: 035 (optional)

LATITUDE: 33 / 01 / 06.0 LONGITUDE: 080 / 10 / 42.0 (optional)

INVENTORY IND: Y REMEDIAL IND: Y REMOVAL IND: N FED FAC IND: N

RPM NAME: Scott Gardner RPM PHONE: 404 - 347 - 2234 (EPA Project Offic

SITE DESCRIPTION: (optional)

25,000 pounds of yarn were buried at the site. The yarn did have trace amounts of mercury and cadmium. The majority of the waste, however, had no mercury or cadmium.

Part 2: Other site information

DATE SITE FIRST REPORTED: __ / __ / __ REPORTED BY: ____________

REASON FOR LISTING: ____________

Reference No. 1

873-5800

	REGION	SITE NUMBER (to be assigned by Hq)
POTENTIAL HAZARDOUS WASTE SITE IDENTIFICATION AND PRELIMINARY ASSESSMENT		2695

NOTE: This form is completed for each potential hazardous waste site to help set priorities for site inspection. The information submitted on this form is based on available records and may be updated on subsequent forms as a result of additional inquiries and onsite inspections.

GENERAL INSTRUCTIONS: Complete Sections I and III through X as completely as possible before Section II (*Preliminary Assessment*). File this form in the Regional Hazardous Waste Log File and submit a copy to: U.S. Environmental Protection Agency; Site Tracking System; Hazardous Waste Enforcement Task Force (*EN-335*); 401 M St., SW; Washington, DC 20460.

I. SITE IDENTIFICATION

A. SITE NAME: EXXON CHEMICAL COMPANY (PLANT SITE)

B. STREET (or other identifier): HWY 78 W

C. CITY: SUMMERVILLE

D. STATE: SC

E. ZIP CODE: 29483

F. COUNTY NAME: Dorchester

G. OWNER/OPERATOR (if known)

1. NAME: Same as Above
2. TELEPHONE NUMBER: 873-5800

H. TYPE OF OWNERSHIP

☐ 1. FEDERAL ☐ 2. STATE ☐ 3. COUNTY ☐ 4. MUNICIPAL ☒ 5. PRIVATE ☐ 6. UNKNOWN

I. SITE DESCRIPTION

a hole was dug & waste put in it

J. HOW IDENTIFIED (*i.e., citizen's complaints, OSHA citations, etc.*)

K. DATE IDENTIFIED (*mo., day, & yr.*)

L. PRINCIPAL STATE CONTACT

1. NAME: John W. Allert
2. TELEPHONE NUMBER: 722-2962

II. PRELIMINARY ASSESSMENT (*complete this section last*)

A. APPARENT SERIOUSNESS OF PROBLEM

☐ 1. HIGH ☐ 2. MEDIUM ☐ 3. LOW 4. NONE ■ 5. UNKNOWN

See Page 4

B. RECOMMENDATION

☐ 1. NO ACTION NEEDED (*no hazard*)

☐ 2. IMMEDIATE SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 3. SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 4. SITE INSPECTION NEEDED (*low priority*)

C. PREPARER INFORMATION

1. NAME: John W. Allert
2. TELEPHONE NUMBER: 722-2962
3. DATE (*mo., day, & yr.*): 3/31/81

III. SITE INFORMATION

A. SITE STATUS

☐ 1. ACTIVE (*Those industrial or municipal sites which are being used for waste treatment, storage, or disposal on a continuing basis, even if infrequently.*)

☒ 2. INACTIVE (*Those sites which no longer receive wastes.*)

☐ 3. OTHER (*specify*): (*Those sites that include such incidents like "midnight dumping" where no regular or continuing use of the site for waste disposal has occurred.*)

B. IS GENERATOR ON SITE?

☐ 1. NO ☐ 2. YES (*specify generator's four-digit SIC Code*):

C. AREA OF SITE (*in acres*)

D. IF APPARENT SERIOUSNESS OF SITE IS HIGH, SPECIFY COORDINATES

1. LATITUDE (*deg.—min.—sec.*)
2. LONGITUDE (*deg.—min.—sec.*)

E. ARE THERE BUILDINGS ON THE SITE?

☐ 1. NO ☐ 2. YES (*specify*):

Continued From Front

IV. CHARACTERIZATION OF SITE ACTIVITY

Indicate the major site activity(ies) and details relating to each activity by marking 'X' in the appropriate boxes.

'X'	A. TRANSPORTER	X	B. STORER	'X'	C. TREATER	'X'	D. DISPOSER
	1. RAIL		1. PILE		1. FILTRATION		1. LANDFILL
	2. SHIP		2. SURFACE IMPOUNDMENT		2. INCINERATION		2. LANDFARM
	3. BARGE		3. DRUMS		3. VOLUME REDUCTION		3. OPEN DUMP
	4. TRUCK		4. TANK, ABOVE GROUND		4. RECYCLING/RECOVERY		4. SURFACE IMPOUNDMENT
	5. PIPELINE		5. TANK, BELOW GROUND		5. CHEM./PHYS. TREATMENT		5. MIDNIGHT DUMPING
	6. OTHER (specify):		6. OTHER (specify):		6. BIOLOGICAL TREATMENT		6. INCINERATION
					7. WASTE OIL REPROCESSING		7. UNDERGROUND INJECTION
					8. SOLVENT RECOVERY		8. OTHER (specify): [illegible] on the dump
					9. OTHER (specify):		

E. SPECIFY DETAILS OF SITE ACTIVITIES AS NEEDED

V. WASTE RELATED INFORMATION

A. WASTE TYPE

☐ 1 UNKNOWN ☐ 2 LIQUID ☒ 3. SOLID ☐ 4. SLUDGE ☐ 5. GAS

B. WASTE CHARACTERISTICS

☐ 1 UNKNOWN ☐ 2. CORROSIVE ☐ 3. IGNITABLE ☐ 4 RADIOACTIVE ☐ 5 HIGHLY VOLATILE
☐ 6 TOXIC ☐ 7 REACTIVE ☒ 8 INERT ☐ 9 FLAMMABLE

☐ 10 OTHER (specify):

C. WASTE CATEGORIES

1. Are records of wastes available? Specify items such as manifests, inventories, etc. below.

2. Estimate the amount (specify unit of measure) of waste by category; mark 'X' to indicate which wastes are present.

a. SLUDGE	b. OIL	c. SOLVENTS	d. CHEMICALS	e. SOLIDS	f. OTHER
AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT
UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE
'X' (1) PAINT, PIGMENTS	'X' (1) OILY WASTES	'X' (1) HALOGENATED SOLVENTS	'X' (1) ACIDS	'X' (1) FLYASH	'X' (1) LABORATORY PHARMACEUT.
(2) METALS SLUDGES	(2) OTHER (specify):	(2) NON-HALOGNTD. SOLVENTS	(2) PICKLING LIQUORS	(2) ASBESTOS	(2) HOSPITAL
(3) POTW		(3) OTHER (specify):	(3) CAUSTICS	(3) MILLING/ MINE TAILINGS	(3) RADIOACTIVE
(4) ALUMINUM SLUDGE			(4) PESTICIDES	(4) FERROUS SMLTG. WASTES	(4) MUNICIPAL
(5) OTHER (specify):			(5) DYES/INKS	(5) NON-FERROUS SMLTG. WASTES	(5) OTHER (specify):
			(6) CYANIDE	(6) OTHER (specify):	
			(7) PHENOLS		
			(8) HALOGENS		
			(9) PCB		
			(10) METALS		
			(11) OTHER (specify)		

Continue On Page 3

Continued From Page 2

[illegible]TE RELATED INFORMATION (continued)

3. LIST SUBSTANCES OF GREATEST CONCERN WHICH MAY BE ON THE SITE (place in descending order of hazard).

4. ADDITIONAL COMMENTS OR NARRATIVE DESCRIPTION OF SITUATION KNOWN OR REPORTED TO EXIST AT THE SITE.

VI. HAZARD DESCRIPTION

A. TYPE OF HAZARD	B. POTENTIAL HAZARD (mark 'X')	C. ALLEGED INCIDENT (mark 'X')	D. DATE OF INCIDENT (mo.,day,yr.)	E. REMARKS
1. NO HAZARD				
2. HUMAN HEALTH				
3. NON-WORKER INJURY/EXPOSURE				
4. WORKER INJURY				
5. CONTAMINATION OF WATER SUPPLY				
6. CONTAMINATION OF FOOD CHAIN				
7. CONTAMINATION OF GROUND WATER				
8. CONTAMINATION OF SURFACE WATER				
9. DAMAGE TO FLORA/FAUNA				
10. FISH KILL				
11. CONTAMINATION OF AIR				
12. NOTICEABLE ODORS				
13. CONTAMINATION OF SOIL				
14. PROPERTY DAMAGE				
15. FIRE OR EXPLOSION				
16. SPILLS/LEAKING CONTAINERS/RUNOFF/STANDING LIQUIDS				
17. SEWER, STORM DRAIN PROBLEMS				
18. EROSION PROBLEMS				
19. INADEQUATE SECURITY				
20. INCOMPATIBLE WASTES				
21. MIDNIGHT DUMPING				
22. OTHER (specify):				

Continue On Reverse

Continued From Front

VII. PERMIT INFORMATION

A. INDICATE ALL APPLICABLE PERMITS HELD BY THE SITE.

☐ 1. NPDES PERMIT ☐ 2. SPCC PLAN ☐ 3. STATE PERMIT *(specify)*:

☐ 4. AIR PERMITS ☐ 5. LOCAL PERMIT ☐ 6. RCRA TRANSPORTER

☐ 7. RCRA STORER ☐ 8. RCRA TREATER ☐ 9. RCRA DISPOSER

☐ 10. OTHER *(specify)*:

B. IN COMPLIANCE?

☐ 1. YES ☐ 2. NO ☐ 3. UNKNOWN

4. WITH RESPECT TO *(list regulation name & number)*:

VIII. PAST REGULATORY ACTIONS

☐ A. NONE ☐ B. YES *(summarize below)*

IX. INSPECTION ACTIVITY *(past or on-going)*

☐ A. NONE ☐ B. YES *(complete items 1,2,3, & 4 below)*

1. TYPE OF ACTIVITY	2. DATE OF PAST ACTION (mo., day, & yr.)	3. PERFORMED BY: (EPA/State)	4. DESCRIPTION

X. REMEDIAL ACTIVITY *(past or on-going)*

☐ A. NONE ☐ B. YES *(complete items 1, 2, 3, & 4 below)*

1. TYPE OF ACTIVITY	2. DATE OF PAST ACTION (mo., day, & yr.)	3. PERFORMED BY: (EPA/State)	4. DESCRIPTION

NOTE: Based on the information in Sections III through X, fill out the Preliminary Assessment *(Section II)* information on the first page of this form.

I spoke with Mr. Jim Nichols, Plant Engineer on 3/31/81. He stated that only on a one time basis they disposed of 25,000 pounds of yarn on the site and covered it with earth. A letter from Mr. Dick Swanson of Exxon to Mr. Charles Kelly confirms apparently that they had approval. A very small part of the yarn did have mercury and cadmium in it in trace amounts, howe Mr. Nichols stated that "the poly substrate ties up these heavy metals when no sunlight hits them and the waste is buried." He also sta that it would be impossible to pull a representative sample because a large part of the waste had no mercury or cadmium.

Reference No. 2

KIRK-OTHMER

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

THIRD EDITION

VOLUME 13

HYDROGEN-ION ACTIVITY
TO
LAMINATED MATERIALS, GLASS

A WILEY-INTERSCIENCE PUBLICATION
John Wiley & Sons
NEW YORK • CHICHESTER • BRISBANE • TORONTO

1981

Table 1 (*continued*)

Substance	CAS Registry Number	Current OSHA environmental standard	NIOSH recommendation for environmental exposure limit[b]	Health effect considered	Comments
benzene	*[71-43-2]*	10-ppm, 8-h TWA; 25-ppm acceptable ceiling; 50-ppm maximum ceiling (10-min)[d]	1-ppm ceiling (3.2 mg/m^3) (60-min)	blood changes including leukemia	blood testing required
benzoyl peroxide	*[94-36-0]*	5-mg/m^3, 8-h TWA	5 mg/m^3 TWA	airway and eye irritation, skin effects	
benzyl chloride	*[100-44-7]*	1-ppm (5 mg/m^3), 8-h TWA	5 mg/m^3 ceiling (15-min)	irritation; skin and eye effects	chest x-ray and pulmonary function testing required
beryllium	*[7440-41-7]*	2 μm/m^3, 8-h TWA; 5-μm/m^3, acceptable ceiling; 25 μm/m^3 maximum ceiling (30-min)	0.5 μm/m^3 (130-min)	lung cancer	pulmonary function chest x-ray, and sputum cytology required
boron trifluoride	*[7637-07-2]*	1-ppm ceiling	none recommended	respiratory system effects	adequate procedures for sampling and analysis not available; pulmonary function testing required
cadmium	*[7440-43-9]*	0.1 mg/m^3, 8-h TWA; 0.3 mg/m^3 ceiling (fume; erroneously published as 3 mg/m^3) 0.2 mg/m^3, 8-h TWA; 0.6 mg/m^3 ceiling (dust)	40 μm CD/m^3, TWA; 200 μm CD/m^3 ceiling (15-min)	lung and kidney effects	urine and pulmonary function testing required
carbaryl	*[63-25-2]*	5 mg/m^3, 8-h TWA	5 mg/m^3, TWA	nervous and reproductive system effects	medical warnings of possible effects on reproductive system and minimum exposure during pregnancy required; skin and eye contact to be prevented
carbon black	*[1333-86-4]*	3.5 mg/m^3, 8-h TWA	3.5 mg/m^3 TWA; 0.1 mg/m^3 TWA in presence of polycyclic aromatic hydrocarbons	lung, heart, and skin effects; cancer	chest x-rays, pulmonary function testing, ECG, and sputum cytology required
carbon dioxide	*[124-38-9]*	5000-ppm, 8-h TWA	10,000-ppm TWA (18,000 mg/m^3) 30,000-ppm ceiling (54,000 mg/m^3) (10-min)	respiratory effects	
carbon disulfide	*[75-15-0]*	20-ppm, 8-h TWA; 30-ppm acceptable ceiling; 100-ppm maximum ceiling	1-ppm TWA (3 mg/m^3); 10-ppm ceiling (30 mg/m^3) (15-min)	heart, nervous, and reproductive system effects	employees to be advised of potential effects on reproductive system
carbon	*[630-08-0]*	50-ppm, 8-h TWA	35-ppm TWA (40 mg/m^3); 200-ppm ceiling (229 mg/m^3)	heart effects	

Table 1 (*continued*)

Substance	CAS Registry Number	Current OSHA environmental standard	NIOSH recommendation for environmental exposure limit[b]	Health effect considered	Comments
malathion	[*121-75-5*]	15 mg/m^3, 8-h TWA	15 mg/m^3 TWA	nervous system effects	skin contact to be prevented; blood monitoring required
mercury, inorganic	[*7439-97-6*]	0.1 mg/m^3 ceiling	0.05 mg/m^3 TWA	central nervous system and mental effects	
methyl alcohol	[*67-56-1*]	200-ppm TWA	200-ppm TWA (262 mg/m^3); 800-ppm ceiling (1048 mg/m^3) (15-min)	blindness; metabolic acidosis	
4,4′-methylene-bis(2-chloro-aniline[c]	[*101-14-4*]	none—standard remanded by court	3 $\mu m/m^3$ TWA; skin contact to be avoided	cancer	chest x-ray, blood and urine testing required
methyl parathion	[*298-00-0*]	none	0.2 mg/m^3 TWA	nervous system effects	skin contact to be prevented; blood monitoring required
methylene chloride	[*75-09-2*]	500-ppm, 8-h TWA; 1000-ppm acceptable ceiling; 2000-ppm maximum (5-min in 2 h)	75-ppm TWA (261 mg/m^3); 500-ppm ceiling (1740 mg/m^3) to be lowered in presence of carbon monoxide	central nervous system effects; carbon monoxide toxicity	blood monitoring required
nickel carbonyl[c]	[*13463-39-3*]	7 $\mu m/m^3$ (1-ppb), 8-h TWA	7 $\mu m/m^3$ (1-ppb) TWA	cancer	recommendations for chest x-ray, pulmonary function, and urine monitoring
nickel, inorganic and compounds	[*7440-02-0*]	1 mg/m^3, 8-h TWA	15 μm Ni/m^3 TWA	skin effects; lung and nasal cancer	chest x-ray and pulmonary function testing required
nitric acid	[*7697-37-2*]	2-ppm, 8-h TWA	2-ppm TWA (5 mg/m^3)	dental erosion, nasal/lung irritation	hazardous liquid, eyes and skin, chest x-ray required
nitriles	[*75-05-8*] [*3333-52-6*] [*78-82-0*] [*107-12-0*] [*111-69-3*] [*110-61-2*] [*75-86-5*] [*107-16-4*]	70 mg/m^3 (40-ppm), 8-h TWA (acetonitrile); 3 mg/m^3, (0.5-ppm), 8-h TWA, (skin) (tetramethylsuccinonitrile)	to be TWA values: acetonitrile: 34 mg/m^3 (20-ppm); *N*-butyronitrile [*109-74-0*]: 22 mg/m^3 (8-ppm); isobutyronitrile: 22 mg/m^3 (8-ppm); propionitrile: 14 mg/m^3 (6-ppm); malononitrile: 8 mg/m^3 (3-ppm); adiponitrile: 18 mg/m^3 (4-ppm); succinonitrile: 20 mg/m^3 (6-ppm) to be ceiling values (15-min): acetone cyanohydrin: 4 mg/m^3 (1-ppm); glycolonitrile: 5 mg/m^3 (2-ppm); tetramethyl-succinonitrile: 6 mg/m^3 (1-	hepatic, renal, respiratory, cardiovascular, gastrointestinal and nervous system effects	chest x-ray and pulmonary function testing required; trained personnel and first-aid kits to be available during use; hazardous substances, skin and eyes

Re-ference No. 3

NUS CORPORATION AND SUBSIDIARIES | **TELECON NOTE**

CONTROL NO:	DATE:	TIME:
	September 14, 1987	1515

DISTRIBUTION:
Plant Site File

BETWEEN:	OF:	PHONE:
Mr. Reynolds	Public Works, Summerville, S. Carolina	(803) 875-8757

AND:
Carol Doran, NUS Corporation CAD 9/14/87

DISCUSSION:
Re: Water System of Summerville

The City of Summerville uses a mix of surface water (from their own treatment plant and water bought from Charleston) and groundwater. The majority of their water comes from their own wells. The wells are 1840 feet deep. The wells are scattered over a large portion of Summerville.

Mr. Reynolds declined to provide anymore information at this point and requested that a list of questions be sent to him so that he could respond in writing.

ACTION ITEMS:

THE GROUND-WATER RESOURCES OF CHARLESTON, BERKELEY, AND DORCHESTER COUNTIES SOUTH CAROLINA

by
A. Drennan Park

**Prepared in cooperation with the
United States Geological Survey
and the
Coastal Plains Regional Commission**

STATE OF SOUTH CAROLINA

**WATER RESOURCES COMMISSION
REPORT NUMBER 139**

1985

ACKNOWLEDGEMENTS

The author wishes to express his thanks to the staff members of the South Carolina Water Resources Commission and USGS for their advice and efforts on behalf of this report. Particular thanks are due Mr. Rodney Cherry, District Chief, USGS, for his support during the project, and to the Coastal Plains Regional Commission, which provided much of the project funding.

The author is also indebted to the staffs of the many public works agencies and the consulting engineers who serve them. Special thanks are also extended to the G.W. Ackerman Well Company and T.A. Clyde Well Drilling for their assistance in obtaining drill samples, geophysical logs, and well-construction data.

GEOLOGIC FRAMEWORK

The rock units underlying Charleston, Berkeley, and Dorchester Counties represent a broad range of lithologies, depositional environments, and ages (Table 1). The oldest units, the Middendorf, Black Creek, and Peedee Formations, are of Late Cretaceous age and were deposited in environments ranging from continental to innershelf marine. Their lithologies are predominantly clastic, consisting of sand, silt, and clay. The bulk of the units overlying the Late Cretaceous formations consists of the Tertiary Black Mingo Formation, Santee Limestone, and Cooper Formation. These units are the result of deposition in marine environments ranging from marginal marine to outer shelf. Sand, silt, and clay dominate the

Table 1. Stratigraphic units and their water-bearing characteristics.

SYSTEM	SERIES	FORMATION	LITHOLOGY	WATER-BEARING CHARACTERISTICS
Quaternary	Holocene and Pleistocene	Terrace Deposits	Highly variable. Light-colored fine-to medium-grained sands, shelly sands, and shell beds; varicolored clays. Locally coarse-grained sand or gravel; thin limestone beds.	Ground water occurs under water-table or poorly confined conditions. Transmissivities are generally less than 1,000 ft²/day. Well yields are variable, ranging from 0 to 200 gpm. Water is commonly acidic at shallow depths and high in iron.
	Miocene	Hawthorn	Fine, sandy, phosphatic limestone, and thin remnents of sand and clay. Generally absent from study area.	
		Edisto	Pale-yellow, sandy, fossiliferous limestone. Present to the northwest along the Edisto River.	
Tertiary	Oligocene	Cooper	Pale-green, or yellowish-gray to olive-brown, sandy, phosphatic limestone. *Harleyville Member:* phosphatic, calcareous clay to clayey, very fine-grained limestone. *Parkers Ferry Member:* glauconitic, clayey, fine-grained, abundantly fossiliferous limestone. *Ashley Member:* phosphatic, muddy, calcareous sands.	Confining unit. Porous bryozoan limestone unit of limited extent will yield up to 300 gpm of freshwater. Yields unknown quantities of brackish water in southern Charleston County.
	Eocene	Santee Limestone	Creamy-white to gray, fossiliferous, locally phosphatic limestone. *Moultrie Member:* biosparrites and bryozoan hash. *Cross Member:* brachiopod-bivalve biomicrite.	Artesian, except in outcrop areas. Typically yields less than 300 gpm. Calcium bicarbonate type water with iron commonly in excess of 0.3 mg/L. Contains brackish water along coast.
Tertiary	Paleocene	Black Mingo	Fossiliferous, white to pale gray limestones, green to gray argillaceous sands, carbonate-and silica-cemented sandstones, and dark-gray to black clays.	Artesian. Transmissivities range from 500 to 8,500 ft²/day. Will yield 300 to 500 gpm in most areas. Water is soft, alkaline, sodium bicarbonate type. Locally, contains high fluoride and brackish water.
		Peedee	Olive-to-medium gray, fossiliferous, muddy sands and olive-to-medium gray, silty and sandy calcareous clays.	Artesian. Poor aquifer, yielding less than 300 gpm. Very mineralized sodium bicarbonate type water with high concentrations of fluoride. Contains brackish water along coast.
Cretaceous	Upper Cretaceous	Black Creek	Gray to gray-green muddy sands, silty clays, fine-to-medium grained white to gray sands, and shelly limestones with minor amounts of glauconite, phosphate, mica, and pyrite.	Artesian. Transmissivities range from 930 to 2,000 ft²/day. Yields 250 to 1,000 gpm. Water is soft, alkaline, sodium bicarbonate type. Fluoride exceeds 1.6 mg/L in eastern half of study area.
		Middendorf	Red, brown, and gray-green, poorly sorted feldspathic sands, and reddish or gray-green clay, silty clay, and clayey silt in lower half. Red, brown, yellow to olive-gray clay and silty clay, and greenish-gray, muddy, locally feldspathic sand in upper half.	Artesian. Transmissivities are probably less than 4,300 ft²/day in most areas. Yields range up to 2,000 gpm. Very mineralized, sodium bicarbonate type water. Fluoride concentrations up to 11 mg/L.
Triassic		Unnamed	Diabase, basalt, or quartzitic sandstone, depending on locality.	Hydraulic properties are unknown. Probably a poor source of water.

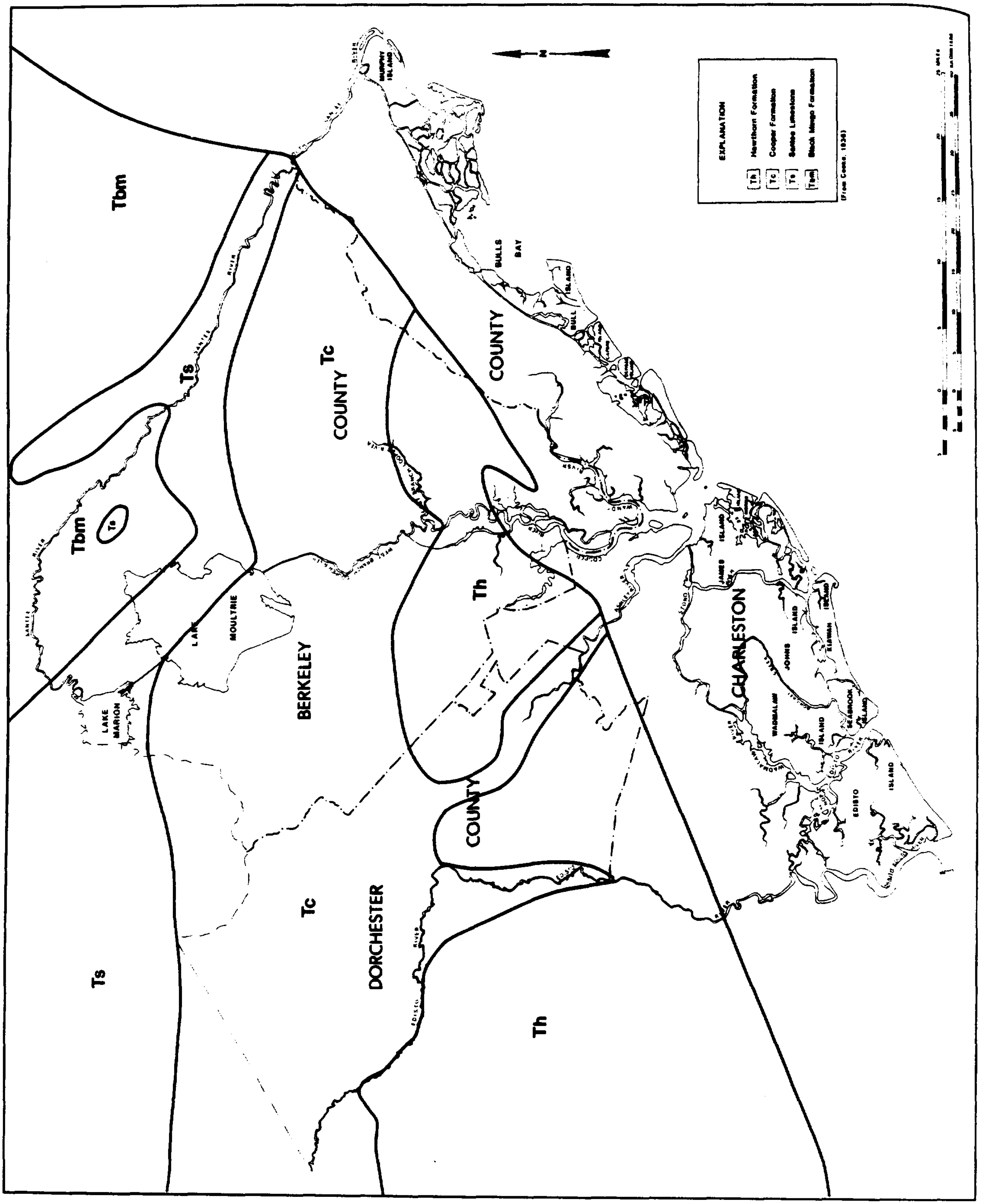

Figure 5. Generalized areal geology of Charleston, Berkeley, and Dorchester Counties.

lithology in the lower part of the Tertiary section, and pure to very impure limestone dominates the upper part. The major Tertiary units are in turn overlain by a shallow sequence of sand, silt, clay, and shell having an average thickness of less than 50 ft. Tertiary and Quaternary rocks are exposed at various locations, and the general distribution of their subcrop areas is shown in Figure 5.

The stratigraphic units that occur in the study area are part of a wedge of successively overlapping formations that thicken coastward from a feather edge at the fall line to about 3,000 ft at the southern extreme of Charleston County. Within the limits of the study area they have an average thickness of about 2,200 ft. The Late Cretaceous units lie at depths of 300 ft or more and crop out 30 to 70 miles north and west of the study area. Their occurrence is defined in cross section (Figs. 6, 7, 8, and 9).

Pre-Cretaceous Basement Rocks

Well-indurated sedimentary rocks and their metamorphic equivalents, volcanic flows, or crystalline rock such as granite underlie the unconsolidated sedimentary formations of the Coastal Plain. These rocks do not represent the true "basement" but are herein referred to as such for convenience.

Recent studies of seismic activity in the Charleston area have greatly modified traditional beliefs concerning the nature of these rocks. It was previously thought that the consolidated rocks underlying the Coastal Plain sediments were buried extensions of metamorphic and intrusive rocks exposed in the Appalachian Piedmont Province. However, the Coastal Plain basement is much different and is more complex than previously supposed.

Much of the basement surface beneath Charleston, Berkeley, and Dorchester Counties is dominated by an extensive volcanic field and large mafic plutons mixed with or separated by units of consolidated clastic rock. Three deep test wells drilled in the area have encountered differing lithologies beneath the unconsolidated Coastal Plain sediments. The basement test well at Summerville is reported to have penetrated volcanic diabase at −2,430 ft msl; the Clubhouse Crossroads well pentrated 138 ft of basalt beginning at −2,430 ft msl and a deep well at Seabrook Island encountered fine-grained quartzitic sandstone at −2,670 ft msl.

The basalt encountered at Clubhouse Crossroads is similar to basalts from the Atlantic-type continental margins of eastern North America, Tasmania, Antarctica, and South Africa and have estimated ages of 94.8 to 109 million years. The basalts are of a type associated with tensional faulting, hence suggesting the existence of a buried Triassic basin beneath the Charleston area (see Gottfried and others, 1977).

The basement surface, shown in Figure 10, dips generally south-southeast at an average rate of about 40 ft per mile. It lies at approximately −1,500 ft msl in northernmost Berkeley and Dorchester Counties, dipping to −3,000 ft msl in southern Charleston County. A troughlike depression in the basement surface west of Charleston has been defined by Campbell (1977) and Ackerman (1977).

Features within the basement rocks are shown in Figure 11. The features include east-west and northwest trending faults through northern Berkeley and Dorchester Counties, large northwestern trending diabase dikes, and several large Triassic (?) plutons whose tops occur at about −4,900 ft msl or about 2,600 ft below the basement surface (see Popenoe and Zietz, 1977). Layers possibly representing deeper volcanic flows or the true crystalline basement have been identified at several depths below the basaltic basement surface (Ackerman, 1977; Campbell, 1977; Phillips, 1977).

Cretaceous Units

Middendorf Formation

The name "Middendorf" was applied by Sloan (1904) to presumed Lower Cretaceous exposures near the town of Middendorf, Chesterfield County, South Carolina. Berry (1914) assigned the unit to the Upper Cretaceous, and C.W. Cooke (1926) revised the terminology and correlations of earlier investigators and included the "Middendorf" and lower beds of Sloan (1907) and the "Middendorf" arkose member of Berry (1914) in the Middendorf Formation. Cooke (1936) later considered the Middendorf and "Hamberg" beds of Sloan to be similar to the Tuscaloosa Formation of Alabama, and he used the name "Tuscaloosa", as did Mansfield (1937). Dorf (1952) referred to the Formation in Chester County as the "Middendorf Member" of the Black Creek Formation and to the underlying rocks as "Lower Cretaceous (undifferentiated." Subsequently, Heron (1958b) and Swift and Heron (1969) returned to the term Middendorf Formation for its occurrence in the Cape Fear area of North Carolina. The USGS has recently used the term for Upper Cretaceous units within the boundaries of the present study area (Gohn and others, 1977; Hazel and others, 1977).

Gohn and others (1977) also described an underlying unit at Clubhouse Crossroads as the "Cape Fear Formation". Gohn and Hazel (1979) suggested that the Middendorf and Cape Fear Formations of Gohn and others (1977) and Hazel and others (1977) are not the same units as those so named in the outcrop areas. Therefore the Middendorf and Cape Fear Formations of Gohn and others (1977) and Hazel and others (1977) are grouped under the name "Middendorf" in this report for the sake of convenience.

The lower 200 ft of the Middendorf Formation (Cape Fear of Gohn and others, 1977) is composed of interbedded red, brown, yellow, or olive-gray clay and silty clay; and greenish-gray, muddy, locally feldspathic sand. The sand and clay contain varying amounts of mica, pyrite, and shell fragments. The upper part of the formation consists of a cyclical sequence of red to reddish-brown and gray-green, poorly sorted feldspathic sand, reddish or red and gray-green mottled clay, clayey silt, and silty clay. The sediments represent continental and marginal marine depositional environments (see Gohn and others, 1977).

The top of the formation occurs at about −1,000 ft msl at St. Stephen, −1,860 ft msl at Clubhouse Crossroads, and at −2,180 ft msl at Kiawah Island. The average dip of the surface of the formation is southwest at about 36 ft per mile. The formation is 600 ft thick at Clubhouse Crossroads and approximately 600 ft thick at Kiawah Island, with the thickness increasing toward the southeast.

Black Creek Formation

Ruffin (1843, p. 25) first noted the black shales in Darlington and Florence Counties that were later referred to as the "Black Creek Shales" by Sloan (1907, p. 12-14), and which Sloan (1908) described as the Black Creek Formation. The term Black Creek Formation has since been used to include the Snow Hill Marl Member (Stephenson, 1923; Cooke, 1926; Dorf, 1952; Heron, 1958a, 1958b) and all or part of the Middendorf Formation as a member. Swift and Heron (1969, p. 217) thought the Black Creek interfingered with the Middendorf (Tuscaloosa), a conclusion predominantly based on outcrop data. Woolen (1978) assembled both outcrop and subsurface data for northeastern South Carolina and suggested a similar contact.

The lithology and paleontology of the formation in the subsurface of the study area were described by Cooke (1936), Mansfield (1937), Gohn and others (1977), Hazel and others (1977), and Hattner and Wise (1980).

Gohn and others (1977, p. 67) describe the formation as abundantly fossiliferous silty clay, muddy sand, and clean sands alternating in 50- to 150-ft thick sequences with thinly interbedded sand and clay and some shelly limestone. The silty clay and muddy sand are gray to gray-green with minor quantities of glauconite, phosphate, mica, and pyrite. Locally, macrofossil shells and microfossil tests are abundant, and the calcium carbonate content is high. Feldspathic quartzitic silt and well-sorted fine sand occur near the base of the formation, and well-sorted calcareous quartz sand occurs in the upper part. The clay has as much as 20 percent black carbonaceous material. Black Creek sediments were deposited in environments ranging from marginal marine to middle shelf (Gohn and others, 1977; Hazel and others, 1977).

The top of the Black Creek Formation occurs at −530 ft msl at St. Stephen, −1,050 ft, at Clubhouse Crossroads, and −1,420 ft at Kiawah Island. The dip is toward the southeast at a rate of about 30 ft per mile. Thickness increases from about 500 ft in northern Berkeley County to 750 ft in southern Charleston County.

Peedee Formation

The Peedee Formation is named for beds cropping out along the Pee Dee River in Florence County. Ruffin (1843, p. 7) first described the "Peedee beds" that were later designated as the "Burches Ferry marl" at a type locality in Florence County by Sloan (1907, p. 12-14). Stephenson (1923) returned to the use of the term "Peedee," which has been retained in subsequent publications. The formation occurs only in the subsurface within the project area.

At Clubhouse Crossroads the formation is represented by calcareous muddy sand and calcareous mud. There, the lower part of the Peedee is predominantly composed of olive- to medium-gray, fossiliferous, muddy sand containing small amounts of glauconite, phosphate, and mica. The upper part is composed of olive- to medium-gray, silty and sandy calcareous caly. Calcium carbonate, in the form of fossils and cement, ranges from 10 to 40 percent; accessory minerals include glauconite, phosphate, pyrite, and mica (Gohn, and others, 1977, p. 68).

The Peedee underlies the entire study area. The top lies at about −200 ft msl in northern Berkeley County, dipping southwestwardly to −800 ft at Clubhouse Crossroads and −700 ft at Charleston. The average dip is about 25 ft per mile. Its thickness ranges from 320 to 450 ft, increasing at about 4 ft per mile toward the south.

Principal Tertiary Units

Black Mingo Formation

The name "Black Mingo" was originally applied to exposures of "shale" along Black Mingo Creek in adjacent Williamsburg and Georgetown Counties by Sloan (1907). He later (1908) used the term "Black Mingo phase" to include all rocks of lower Eocene age east of the Santee River. After mapping the outcrop and subcrop areas, Cooke (1936, p. 41) referred to all Eocene rocks older than the McBean Formation as the "Black Mingo formation". As used in this report, the name is applied to strata referred to as the "Black Mingo" and "Beaufort (?)" Formations by Gohn and others (1977) and Hazel and others (1977).

The Black Mingo is a heterogeneous, fossiliferous sequence of white to pale-gray limestone, green to gray argillaceous sand, carbonate and silica-cemented sandstone, and dark-gray to black clay. In the outcrop areas of northern Berkeley County, the formation chiefly consists of clay, shale, sand, and limestone; shale and clay being more abundant in the lower part, and sand and limestone being more prevalent in the upper part. The sand is white to pale gray in the absence of glauconite and pale green to dark green where glauconite is present (Taber, 1939, p. 4; Poozer, 1965, p. 11; Spiers, 1975, p. 15). Montmorillonite clay is common in the updip portion of the Black Mingo (Heron, 1969, p. 34; Heron and others, 1965) and is commonly dark gray with small quantities of pyrite. Lithological and paleontological data indicate that the updip portion of the Black Mingo was deposited in inner-shelf and marginal-marine environments (Poozer, 1965, p. 11). Downdip, the subsurface section at Clubhouse Crossroads reflects a broader range of depositional environments. The lower segment (Beaufort (?) of Gohn and others (1977)) is predominantly a yellow-gray to greenish-gray, somewhat calcareous or sandy clay including glauconite, carbonized wood, and pyrite, generally deposited in an inner- or middle-shelf environment. The overlying segment is similar, consisting of gray-green silty clay and muddy sand, interbedded sand and clay, and quartzose shelly limestone. Illite is the most common clay mineral. Gohn and others (1977) suggested that these sediments are the result of inner-shelf and marginal marine environments.

Black Mingo sediments generally are a mixture of detrital material and volcanic ash (Heron, 1969, p. 28). The silicate minerals, opal and clinoptilolite, are common in the updip regions of the formation (Heron, 1969, p. 37), and cristobalite is reported to be abundant in much of the formation in the Clubhouse Crossroads corehole (Gohn and others, 1977, p. 63).

The formation crops out north of Moncks Corner in Berkeley County and throughout much of adjacent Georgetown and Williamsburg Counties. Its surface dips south-southwest beneath the Santee Limestone at a rate of 17 ft per mile, lying at sea level in the vicinity of Bonneau in Berkeley County and dipping to more than −600 ft msl in southern Charleston County (Fig. 12). The formation thickens from approximately 300 ft at Moncks Corner to 400 ft at Seabrook Island.

Santee Limestone

Early geologists grouped the undifferentiated Santee Limestone and Cooper Formation with the Upper Cretaceous, until Lyell classed them with the Eocene. Tuomey (1848, p. 154-169) and Clark (1891, p. 52-54) differentiated between the Eocene "Santee beds" and the overlying Cooper Formation, and Sloan (1908, p. 462-463) later applied the names "Santee marl" and "Mt. Hope marl" to the limestone. In 1936, Cooke (p. 75) gave the name "Santee Limestone" to limestone he then considered as part of the Eocene Jackson Group but which he and F.S. MacNeil (1952, p. 24) later identified with Claiborne units. The Santee Limestone is a creamy-white to gray, fossiliferous and slightly glauconitic calcilutite to calcirudite. In the outcrop areas it usually contains more than 80 percent calcium carbonate, and locally it contains 90 to 96 percent calcium carbonate (see Heron, 1962). The base of the limestone becomes increasingly glauconitic and arenaceous at the north edge of the outcrop, where it intertongues with underlying limestone of the Wharley Hill Formation (Poozer, 1965, p. 16-17). Downdip, the calcium carbonate content decreases to between 40 and 80 percent, and quartz sand, glauconite, and phosphate percentages increase (Gohn and others, 1977, p. 68-69). The distribution of carbonates and sediments is shown in Figure 13.

Two members have been recognized within the Santee Limestone, the lower unit being referred to as the Moultrie Member and the upper unit as the Cross Member. The Moultrie Member is characterized by biosparites in the form of mold and cast limestone and bryozoan hashes of a Middle Claibornian age. The Cross Member unconformably overlies the Moultrie and consists of a brachiopod-bivalve biomicrite of late Clairbornian age (Ward and others, 1979). The upper surface of each member tends to be rich in phosphate and can be identified by a marked departure from the zero baseline on natural gamma-ray logs (Fig. 14).

The Santee Limestone lies on the southern flank of the Cape Fear Arch, from which it has been partially eroded. It extends south and west of the arch and underlies all of the study area except the northernmost corner of Berkeley County. It occurs at shallow depths in a belt extending westward from northeastern Charleston County into southern Orangeburg County (Fig. 5). The limestone is overlain by a thin veneer of Miocene to Pleistocene sand and clay in the subcrop area and by the Cooper Formation south of parallel 32° 11 '00". The surface of the Santee dips southward at an average rate of 8.3 ft per mile between Moncks Corner and Edisto Beach. The dip averages 6 ft per mile in the outcrop area, and locally is as much as 17 ft per mile in the subsurface (Fig. 15). Its thickness increases southward at an average rate of 5 ft per mile and ranges from a few feet at the north edge of the limestone to more than 300 ft at Edisto Beach (Fig. 16).

Cooper Formation

The Cooper Formation is the most extensively studied rock unit in the Trident Area; its earliest observers included Vanuxem (1826), Morton (1834), and Lyell (1845). Toumey (1845) differentiated between the Cooper Formation and the underlying Santee Limestone. Between 1867 and 1920, when the Charleston area was a major source of agricultural lime and phosphate, the Cooper Formation received further attention from Holmes (1870), Moses (1872), Rogers (1914), and numerous others (Malde, 1959, p. 4). Many additional reports, addressing the Cooper in part or in whole, have resulted from recent USGS investigations into the Charleston earthquake of 1886. These include Gohn and others (1977), Hazel and others (1977), Higgins and others (1978), and Ward and others (1979).

The names applied to the formation have been varied. Ruffin (1843, p. 7), in describing the "Great Carolina beds" (present Cooper Formation and Santee Limestone), referred to "Marl of the Ashley and Cooper Rivers . . . ". His predecessors used a great number of other terms: "Cooper River Beds" (Holmes, 1870), "Cooper River Marls" (Dall 1898), "Ashley Marl" and "Cooper Marl" (Sloan, 1908), and others. Reports between Stephenson (1914) and Hazel (1976) generally referred the formation as the "Cooper Marl". Malde (1959, p. 10) and Poozer (1965, p. 20) noted that the formation was not a true marl because of its small clay component and large sand component, and the USGS has since accepted the name "Cooper Formation" (Hazel, 1976, p. 54; *in* Cohee, 1976).

Early nineteenth century geologists assigned the Cooper Formation and underlying limestones to the Upper Cretaceous until Charles Lyell (1845, p. 434) pronounced the formations Eocene. Toumey (1884), Holmes (1870, p. 13), and Cooke (1936, p. 72) also classed the Cooper with the Eocene, but Dall (1898), Cooke and McNeil (1952, p. 27), Malde (1959, p. 25), and Poozer (1965, p. 22) referred it to the Oligocene. Hazel and others (1977, p. 74-75) give evidence that the Cooper contains both Eocene and Oligocene beds.

Lithologically, the Cooper Formation is a sandy, phosphatic limestone that is uniform in color and texture and has no obvious signs of bedding. Malde (1959, p. 9), referring mainly to surface exposures, describes the formation as "carbonates (25-75 percent), sand (10-45 percent), clay (2-3 percent), and phosphate (5-20 percent). A description of a core taken near Summerville is similar: calcium carbonate (60-75 percent), quartz sand (5-25 percent), clay (10-30 percent), phosphatic sand and pebble (1-5 percent), and small amounts of glauconite, bone, shell hash, and mica (Gohn and others, 1977, p. 69). The carbonate component consists principally of foraminiferal shell (Malde, 1959, p. 9, 12; Gohn and others, 1977, p. 69). Color ranges from pale-green or yellowish gray to olive brown, becoming lighter when dried.

The Cooper has been divided into three members, which are, in ascending order; Harleyville Member (Eocene), Parkers Ferry member (Eocene), and Ashley member (Oligocene) (Ward and others, 1979, p. 14-26). The Harleyville varies from a phosphatic, calcareous clay and clayey calcarenite at the type exposure to a clayey, very fine-grained limestone in the subsurface. It thins out northward toward the Santee River and thickens toward Charleston, filling a local basin. The overlying Parkers Ferry Member is a glauconitic, clayey, fine-grained limestone with abundant microfossils and mollusk and bryozoan fragments; the unit occurs only in the subsurface and is absent in northern Berkeley and Dorchester Counties. Phosphatic, muddy, calcareous sand comprises the Ashley Member, which unconformably overlies the Parkers Ferry Member and, locally, the Harleyville Member (Ward and others, 1979, p. 14-26).

The Cooper Formation underlies most of the area south of the Santee River and occurs near land surface in a 12- to 20-mile wide east-west trending belt through upper Charleston, Berkeley, and Dorchester Counties. It thickens southward from a few feet in the vicinity of Moncks Corner to more than 300 ft at Edisto Island (Fig. 17). Its surface dips south-southeast at 8 ft per mile, occurring at about 80 ft msl in northern Dorchester County and 40 ft msl in southern Charleston County (Fig. 18; also see Malde, 1959, plate 2; Colquhoun, 1961).

Locally, the surface of the Cooper exhibits a relief of 15 to 20 ft. The greatest relief occurs within an erosional basin in the vicinity of Charleston and is on the order of 40 to 50 ft. Higgins and others (1978, Fig. 1) depict a similarly oriented basin in the underlying Eocene surface of the Cooper. Intraformational units also contain some signs of faulting that are not readily apparent at the surface of the Cooper, according to Colquhoun and Comer (1973). However, the apparent discontinuities observed in their seismic data could instead be related to erosion.

Shallow Tertiary and Quaternary Units

Edisto Formation

Ward and others (1979, p. 26) have applied the name "Edisto Formation" to the pale-yellow, sandy, fossiliferous limestone that overlies the Cooper Formation in western Dorchester County. They designated the left bank of the Edisto River, 0.3 mile above S.C. Highway 61 near Givhans as the lectostratotype. Sloan (1908) originally applied the name "Edisto Marl"; Cooke (1936, p. 86) grouped it with the Eocene Cooper Formation in the vicinity of Givhans; and Malde (1959, p. 26) separated it from the Cooper, referring to the formation under the heading of "Lower Miocene (?) Deposits". The Edisto Formation occurs as an erosional remnant southwest of the type location and pinches out to the northeast. In the vicinity of the Ashley River, Sloan's "Edisto Marl" is grouped with the Hawthorn Formation by Cooke (1936, p. 113-115); Ward and others restricted the unit to the area northwest of U.S. Highway 17 at the Edisto River.

Hawthorn Formation

The Hawthorn Formation was named from the town of Hawthorne, Alachua County, Florida (Dall and Harris, 1892, p. 107). C.W. Cooke (1936, Fig. 2) mapped the Hawthorn into South Carolina as far north as Charleston, including parts of Sloan's (1908) "Ashley" and "Edisto Marls" and generally describing the formation as a middle Miocene "fine sandy, phosphatic limestone". Johnson and Geyer (1965, p. 4) reported that the Hawthorn occurs as a feather edge along the Edisto River, dipping south-southwest and attaining a thickness of about 120 ft. The Hawthorn appears to have been removed by erosion in the Charleston area but may occur locally as thin remnants of sand and clay (Malde, 1959, p. 28).

Pleistocene Formations

Pleistocene deposits within the limits of the study area provisionally are represented by the "Wicomico", "Penholoway", "Talbot", and Pamlico" Formations (see Cooke, 1936, p. 130-154). The names were adopted from work by Shattuck (1906), Stephenson (1912), Cooke (1925), and others. Cooke described the formations as resulting from a glacially controlled Pleistocene sea whose retreat was periodically interrupted by rises of sea level. The result was a topographic succession of terraces and abrupt shorelines cut during interglacial stands of sea level. The local occurrence of each formation was therefore determined on the basis of topographic elevation, as well as by lithology. Thus the Wicomico lies between +100 ft and +70 ft msl; the Penholoway lies between +70 ft and +42 ft msl; the Talbot lies between +42 ft and +25 ft msl; and the Pamlico lies between +25 ft and 0 ft msl. Differing and more detailed interpretations of the geomorphology and lithology of these units have been published by Flint (1940), Richards (1943, 1959), Doering (1958, 1960), Maulde (1959), Colquhoun (1961, 1962, 1969), and others.

The Wicomico generally is composed of fine sand, but it contains some clay, coarse sand, and gravel locally. Estuarine deposits are coarser and contain more gravel than sediments deposited in the open sea. The thickness averages less than 25 ft and rarely exceeds 50 ft (Cooke, 1936, p. 143). As the result of leaching, carbonate clastics are scarce (Colquhoun, 1961, p. 48).

Cooke (1936, p. 147-148) defined the Penholoway as deposits laid down when the sea was about 70 ft above present mean sea level. He gave three locations in Dor-

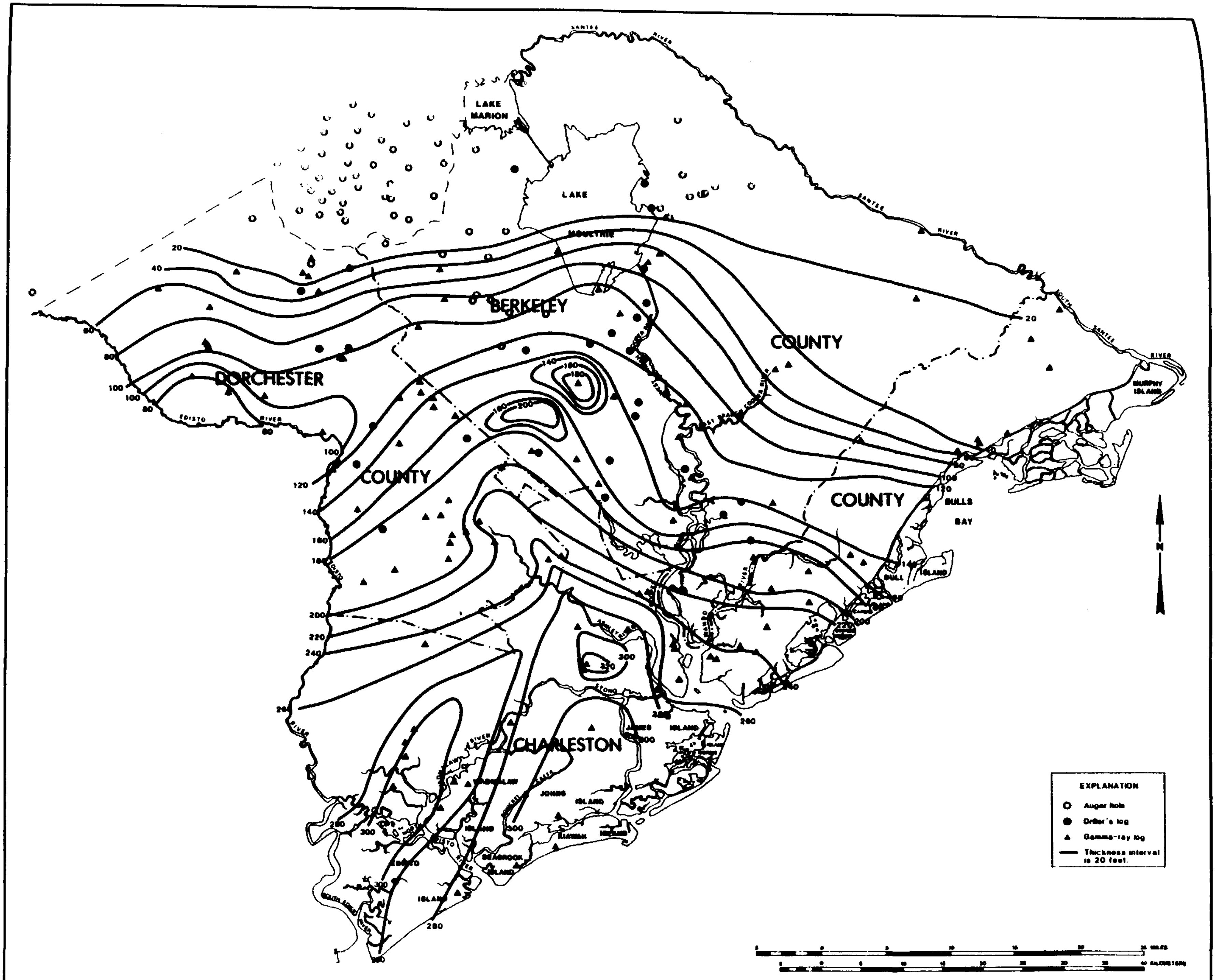

Figure 17. Thickness contours for the Cooper Formation.

chester County and described a section at Four Hole Swamp as 4½ ft of "dark grey pebbly sand . . . passing upward into fine black carbonoecqus sand" overlain by 15 ft of "Fine white crossbedded sand weathering yellow (beach or river deposit)". Locally, coarse basal sands in the Penholoway appear similar to those underlying the Wicomico (Colquhoun, 1962, p. 72). Penholoway sediments are reported to overlap those of the Talbot in the vicinity of Summerville (Malde, 1959, p. 36).

The Talbot Formation generally consists of very fine gray to red or pink thin-bedded sand and clay. Malde (1959, p. 36) includes it as a unit within his "Ladson Formation". According to Cooke (1936, p. 149), the Talbot may have been formed in bays and drowned river valleys. The landward limit of the Talbot is represented by an abandoned shoreline lying at +42 ft msl.

As described within the confines of the study area, the Pamlico Formation occurs at and below the 25-ft topographic contour. Adapting a section described by Sloan (1908) at Johns Island in Charleston County, Cooke (1936, p. 151) listed a section containing 5 ft of green glauconite clay-sand, underlain by 3 feet of sand, in turn underlain by 2 ft of Pleistocene shell. Pugh (1905) reported 179 species of shells collected from the formation in the vicinity of Charleston. The thickest sequence of Pamlico deposits occurs in the coastal section of Charleston County where 40 to 60 ft of sand, clay, and shell overlie the Cooper Formation.

HYDROGEOLOGY

General Principles of Ground-Water Occurrence

The occurrence, movement, availability, and chemical quality of ground water in Charleston, Berkeley, and Dorchester Counties are intimately related to the geology. Ground water is obtained from aquifers, geologic formations that are capable of yielding water to wells or springs. Aquifers in the study area consist of sand and limestone. Confining beds overlie or underlie aquifers and are strata that cannot yield appreciable amounts of water to wells or springs. The confining beds identified in the study area are composed of sandy limestone and clay.

Ground water in an aquifer may occur under artesian (confined) or water-table (unconfined) conditions. The water level in a tightly cased well penetrating the first few feet of a water-table aquifer defines the water table, on which the pressure is atmospheric only.

Artesian aquifers are contained by confining beds. Ground water in artesian aquifers is under pressure, as in a pipe, and the water level in a well completed in an artesian aquifer will rise above the top of the aquifer. The water level in such a well represents a point on the potentiometric surface, an imaginary surface to which water will rise in tightly cased wells completed in the same aquifer. The slope of the potentiometric surface determines the direction of flow of water in an artesian aquifer.

Ground water flows from areas of recharge to areas of discharge. The rate of ground-water movement is dependent upon the hydraulic gradient and the hydraulic conductivity. Hydraulic gradient is the change in hydrostatic head per unit of distance and is usually expressed in feet per mile. Hydraulic gradients are determined from the slope of the potentiometric surface.

The quantity of water that can be pumped or will flow from a properly constructed well is dependent upon certain properties of the aquifer being tapped. These properties include the hydraulic conductivity, transmissivity, and storage coefficient. Aquifer properties can be determined by means of aquifer tests and the use of specific formulas and graphical computations. When these methods are combined with adequate geologic knowledge of an area, useful projections of ground-water availability can be made.

Hydraulic conductivity (K) is the ability of an aquifer to transmit water. It is the rate of flow, in feet per day or meters per day, through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot at the prevailing water viscosity.

Transmissivity (T) is the rate of flow of water, at the prevailing water temperature, through a vertical strip of the aquifer 1 foot wide and extending the full saturated height of the aquifer under a hydraulic gradient of 1 foot per foot. Transmissivity is K multiplied by aquifer thickness (m) and is expressed in ft^2/day or m^2/day (reduced forms of ft^3/day/ft and m^3/day/m).

Storage coefficient (S) is related to the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. The storage coefficient is a dimensionless term, and typical values range between 0.3 and 0.03 for water-table aquifers and between 0.005 and 0.0005 for artesian aquifers. Values from 0.03 to 0.005 indicate conditions that are neither truly water-table nor artesian (American Water Works Association, 1973.)

A characteristic of wells commonly utilized by well drillers, hydrologists, and engineers, and which is related to K, T, and S, is specific capacity. The specific capacity of a well is the rate of discharge divided by the drawdown in water level after a specified period of time (commonly 24 hours) and is expressed as gallons per minute per foot. Specific capacity can be used to compare the performance of wells and to estimate transmissivity, but not storage coefficient.

Middendorf Formation

The Middendorf Formation occurs throughout the study area and is the most extensive water-bearing formation in the South Carolina Coastal Plain. It underlies nearly all of the Coastal Plain Province between North Carolina and Alabama. In the areas north and west of Charleston, Berkeley, and Dorchester Counties, it is greatly relied upon where large quantities of water are required for public supply, industry, and irrigation.

Few wells in the study area obtain water only from the Middendorf Formation. The aquifers in the overlying formations are less expensive to develop and, in most areas, contain water of equal or better chemical quality. Wells screened in the formation usually are screened in the overlying Black Creek Formation also. Only two test wells, 19Y-w3 and 18AA-e2, and four production wells, 18W-a1, 18W-a5, 18W-b1, and 18AA-e4, are screened solely in the Middendorf Formation.

Well 18AA-e4, located north of Goose Creek, was constructed with 88 ft of screen set between −1,510 and −1,640 ft msl, in the upper 200 ft of the formation, and is by far the most productive well in the study area. During initial testing it yielded more than 2,000 gpm, and non-pumping flow was greater than 900 gpm. A pumping test conducted by maintaining non-pumping flow at 800 gpm indicated a specific capacity of 17 gpm/ft. Middendorf aquifer wells 18W-a1 and 18W-a5, at St. Stephen, yield 300 to 500 gpm with specific capacities on the order of 8 gpm/ft.

Only limited hydraulic data are available from pumping tests in Charleston, Berkeley, and Dorchester Counties. However, it is apparent that the transmissivity and hydraulic conductivity of Middendorf aquifers are far lower in the study area than in areas to the west. Siple (1975, p. 35) estimated transmissivities as great as 21,000 ft^2/day in central Orangeburg County. The average transmissivity calculated for several sites in Sumter and Richland Counties was about 6,000 ft^2/day (Park, 1980, Table 3). The highest transmissivities observed are at the Savannah River Plant in Aiken and Barnwell Counties, where an average value calculated for 25 pumping tests was 20,000 ft^2/day (Siple, 1967b, p. 31-35). These high transmissivities occur in areas where the Middendorf Formation contains coarse-grained deltaic deposits that are generally absent in the study area.

The transmissivity of sand beds in the upper 100 to 150 ft of the formation may lessen toward the southeast where drill samples and geophysical logs generally indicate thinner, finer-grained sand beds that were deposited in delta-fringe and marginal-marine environments.

Medium- to coarse-grained sand beds are reported in the lower section of the formation near St. George (25Z-b1), Clubhouse Crossroads (23CC-i1), and Seabrook Island (20GG-e1). However, core and drilling-sample descriptions indicate small amounts of silt and clay that may significantly reduce permeability. Test well 18AA-e2 produced only 1½ gpm with 43 ft of drawdown during a "packer" test on the lower section.

Although transmissivities in the study area may locally be greater than those estimated for the Goose Creek area, they probably do not approach the transmissivities that exist in the Upper Coastal Plain and Middle Coastal Plain Provinces of South Carolina.

Throughout the study area, static water levels in the Middendorf Formation are above land surface. The static level at well 18AA-e2 is about +120 ft msl, and in well 20GG-e1, at Seabrook Island, the static level is +140 msl (Walter Aucott, USGS, written communication). Ground water in the Cretaceous aquifers has generally been assumed to flow toward the south or southeast. However, the static levels in wells penetrating the Middendorf Formation at Hilton Head Island and Parris Island, 50 to 60 miles to the southwest, are 10 to 40 ft higher than the levels measured near Moncks Corner, Goose Creek, and Seabrook Island. Thus it appears that the potentiometric surface slopes toward the east, or possibly the east-northeast.

Black Creek Formation

The Black Creek Formation generally is not as productive as the underlying Middendorf Formation and is largely undeveloped. Eleven wells are open only to the Black Creek Formation and another 10 wells are screened in both the Black Creek and Middendorf. Thirteen of these wells are incorporated in public water-supply systems that typically blend Black Creek and Middendorf aquifer water with that of shallow wells or with surface water.

The Black Creek wells in operation in 1983 were located at Hampton Plantation, in northern Charleston County, and in the vicinities of Jamestown, St. Stephen, and Mt. Pleasant. The well at Hampton Plantation (12Y-L1) and the two wells at Jamestown (15X-L1 and 15X-L5) have 40 to 60 ft of screen set opposite sand in the upper 200 ft of the Black Creek Formation. These wells produce 125 to 275 gpm and have specific capacities of 0.8 to 2.3 gpm/ft.

Two Mt. Pleasant Water Works and Sewer Commission wells (16CC-y1 and 17DD-m5) are screened in the lower 200 ft of the Black Creek Formation and, within the study area, are the highest yielding wells in the formation. Both wells have been tested at discharges greater than 700 gpm, with specific capacities of 2.5 gpm/ft for 16CC-y1 and 4.8 gpm/ft for 17DD-m5. Well 19CC-x1, northwest of Charleston, was screened in corresponding sand beds, but it produces only 240 gpm with a specific capacity of 0.8 gpm/ft.

Wells screened in both Black Creek and Middendorf aquifers are, on the whole, better producers than are those screened only in the Black Creek Formation. In the St. Stephen area, industrial and public-supply wells that have 50 to 60 ft of screen set between 1,060 and 1,260 ft are pumped at 270 to 400 gpm. Specific capacities range from 6 to 10 gpm/ft. The two wells operated by the Town of Summerville have approximately 65 ft of screen set between 1,600 and 1,700 ft and yield about 500 gpm with a specific capacity of 4 gpm/ft. One of these, well 21BB-m3, was tested at 900 gpm.

Comparable wells in the Mt. Pleasant area have been between 80 and 100 ft of 8-inch diameter screen set in the interval of 1,800 to 1,975 ft. These wells produce 400 to 1,000 gpm and have specific capacities of 4.1 to 7.8 gpm/ft.

Transmissivity and hydraulic-conductivity estimates were made for four sites in the study area on the basis of aquifer tests at Jamestown (well 15X-L1) and Mt. Pleasant (wells 17DD-g1, 17DD-m5, 16CC-y1). In each test, water-level measurements were made only in the pumping well; no observation wells were used. The wells were shut down for at least 24 hours prior to the beginning of their tests, and drawdown and recovery measurements were made over a 48-hour period. Transmissivity calculations were based on the recovery data, which are illustrated for well 16CC-y1 in Figure 19. The values for hydraulic conductivity were obtained by dividing the transmissivity by the length of screen in the pumped well. Tests of this nature do not account for the effects of partial screen penetration, multiple screen locations, or well inefficiency; nor do they permit calculation of the storage values.

The data from the test at Jamestown indicate a transmissivity of about 930 ft^2/day and an average hydraulic conductivity of 19 ft/day. This well is mainly screened in the upper half of the Black Creek system, and it is possible that more permeable sand exists at greater depths in the Jamestown area.

The transmissivities calculated for the Mt. Pleasant area were only slightly greater than that for Jamestown. They range from approximately 1,200 ft^2/day, at wells 16CC-y1 and 17DD-m5, to about 2,600 ft^2/day at 17DD-g7, which is screened in both Black Creek and Middendorf aquifers. Hydraulic conductivities range from 21 to 32 ft/day.

Zack (1977, p. 31) reported the values of transmissivity and hydraulic conductivity for the Black Creek System at 14 well sites in Horry and Georgetown Counties. His calculations indicated that transmissivities there range from 390 to 5,350 ft^2/day and that hydraulic conductivities range between 2 and 59 ft/day. He reported storage coefficients that range from 0.0001 to 0.0004.

The transmissivity and hydraulic conductivity values measured in the study fall well within the range of values reported for Horry and Georgetown Counties, although they are somewhat below the averages of 1,733 ft^2/day and 30 ft/day reported by Zack (1977). Nonetheless, a comparison of pumping-test data for Black Creek wells in the study area, Horry County, and Georgetown County indicate similar hydraulic characteristics.

Water levels in the Black Creek Aquifer System are generally higher than +80 ft msl, except in the vicinity of the major pumping centers and in the northeastern section of the study area. Ground water in the system evidently moves toward the east, since static levels of about +160 ft msl are reported at Walterboro, in Colleton County; Zack (1977) reported levels of +20 to zero feet msl in Georgetown County.

A noticeable cone of depression exists in the vicinity of Mt. Pleasant, where six public supply wells withdraw about 1.5 mgd from the Black Creek and Middendorf aquifers. The static level at well 17DD-a4, near the center of the cone of depression, has declined from approximately +90 ft msl in 1973 to +53 ft msl in 1983. The decline should be a matter of concern, since relatively high chloride concentrations have been observed in Black Creek aquifers near Charleston. The chlorides suggest the existence of saltwater-bearing zones to the east, from which saltwater could intrude as pumping increases and water levels decline further.

Peedee Formation

Scant information is available for the Peedee Formation. The earliest known Peedee well was drilled for the City of Charleston in 1823 and penetrated to a depth of 1,250 ft. Two wells of similar depth and construction were drilled in 1849 and 1896; both of which were disappointments in the quantity and the quality of ground water produced. Since that time, no Peedee wells have been drilled in the Charleston area.

Less than 10 Peedee wells are known to have been drilled in the remainder of the study area. Of these, only one, which belongs to the Town of Moncks Corner, is fully cased and screened. That well has a total depth of 807 ft and has 8-inch diameter screen set between 633 and 693 ft. When drilled, the well had a static water level above land surface (55 ft msl) and produced 200 gpm with 240 ft of drawdown for a specific capacity of 0.8 gpm/ft.

For central Orangeburg County, Siple (1975, p. 36) and the writer have observed coarse-grained, well-sorted Peedee sand that suggests highly permeable zones, at least locally. However, the facts that the Peedee is largely ignored as a source of water supply in the study area and that the few wells tapping it have very modest yields attest to the generally low transmissivity of the formation. This characteristic is not unique to the present study area. Siple (1945, 1957) reports that the permeability of Peedee sand is quite low in most areas of the Coastal Plain and that water levels in the system are substantially affected in areas of heavy pumping.

Water levels in the Peedee are above land surface throughout most of the study area, but the direction of ground-water movement is not known. USGS records report water levels higher than +25 ft msl at Charleston and Sullivans Island; well 18DD-k1 at Charleston had a static head of 29.5 psi (70 ft msl) in April, 1983; and well 19Y-s1 had a static level greater than 55 ft msl when completed in September, 1975.

Santee Limestone and Black Mingo Formation

The Santee Limestone in Charleston, Berkeley, and Dorchester Counties is the northernmost segment of one of the most extensive limestone aquifers in the United States. It is part of a series of limestone formations that extend southward from the Santee River into eastern and southeastern Georgia, Florida, and adjacent parts of Alabama. Formations within the system occur near land surface in a southeast-trending belt between Tallahassee and Tampa, Florida, and in a northeast-trending belt that parallels the fall line from Alabama to southeastern South Carolina. The system dips coastward and away from the Cape Fear Arch of North Carolina and the Peninsula Arch and Ocala uplift of Florida, thickening from a few feet in the outcrop areas to more than 12,000 ft in parts of Florida.

The limestone is an important source of fresh ground water in many parts of the Trident Area. As defined for the purposes of this report, it includes the lower Eocene "Fishburne Formation" of Gohn and others (1981), the middle Eocene Santee Limestone, and, locally, the uppermost limestone of the Paleocene Black Mingo Formation. Its lower boundary is everywhere marked by sand or clay of the Black Mingo, and, except in the northern portion of the study area, it is overlain by the Eocene and Oligocene Cooper Formation. The Cooper Formation is an effective confining unit, resulting in artesian conditions throughout most parts of the Santee Limestone.

The Black Mingo Formation underlies all of the study area, thinning out toward the north where it crops out in Sumter, Clarendon, Williamsburg, and Georgetown Counties, and thickening toward the south. Rocks of equivalent age extend into Georgia where they are generally undifferentiated in eastern Georgia and are assigned to the Tuscahoma, Nanafalia, and Clayton Formations in western Georgia. Ground water in the Black Mingo Formation occurs under artesian conditions except in the outcrop areas where water-table conditions may exist in the upper few feet of the aquifer.

Well Construction

Most wells tapping the Santee Limestone and the Black Mingo Formation are of open-hole construction. Because the limestones are poorly productive in many areas, wells typically penetrate the entire thickness of the limestone as well as sand beds in the upper 20 to 100 ft of the Black Mingo Formation. During development, large amounts of sand are pumped from the well, leaving a small cavity at the base of the well bore. This practice is generally satisfactory if the sand is overlain by limestone or hard clay, if large quantities of water are not required, and if the well does not penetrate the Black Mingo too deeply. A number of wells having as much as 500 ft of hole open to the Black Mingo and Peedee Formation are reported to have operated successfully in the past, but have since collapsed or been plugged by debris.

The local practice of constructing open-hole wells in unconsolidated rock carries the risk of partial well collapse. However, the chance of well failure is small if only a few feet of unconsolidated material is penetrated, and the risk is largely offset by the savings in casing and screen costs. The greater concern lies with the risk of interconnecting freshwater-bearing and saltwater-bearing aquifers and is discussed later in the section on water quality.

Domestic open-hole wells are typically 4 inches in diameter and are pumped by ½- to 1- horsepower submersible or jet pumps.

Irrigation and industrial wells are commonly 6 to 10 inches in diameter and are equipped with submersible or conventional turbine pumps of up to 40 horsepower.

Where the Cooper Formation is present, casing is set 20 to 100 ft into the formation; elsewhere the casing is usually seated a few feet below the top of the limestone or in Black Mingo clay. Both steel and polyvinyl chloride (PVC) casing are used, but PVC is the better choice for coastal areas where the ground water is brackish and corrosive.

Industrial and public supply wells have 20 to 100 ft of cement grout and usually have sanitary seals at the well head. However, domestic wells commonly are not grouted, and sanitary seals are often inadequate or nonexistent.

Wells completed only in the Black Mingo sand beds are usually screened. Because the sand is typically fine grained, a screen slot size of 0.015 inch or less is used locally, unless the well is to be constructed with a gravel filter. The gravel filter helps control the entrance of fine sand into the well and allows the use of larger screen openings. Slot sizes reported for gravel-filter wells range between 0.020 and 0.040 inch.

Water Bearing Zones and Well Yields

The permeable zones in the Santee Limestone consist of permeable limestone confined by layers of lower permeability limestone. Where the confining beds extend over a large area, the permeable zones are isolated from one another and have different hydraulic characteristics.

The conditions of ground-water occurrence and movement in these zones are not entirely analogous to those in sand-and-gravel aquifers. In the limestone, the ground water available to wells occurs in fractures and openings along bedding planes. As water moves through the fracture system, the limestone is dissolved, the fractures are enlarged, and the permeability increases. However, the permeability development is not uniform with depth or locality, for it is strongly controlled by factors such as the proximity to recharge areas, the chemistry of the ground water, and local variations in lithology and geologic structure.

Both the degree of permeability development and the position of water-bearing zones relative to the thickness of the aquifer vary from one part of the study area to another. Water-bearing limestone is believed to occur within the upper 50 ft of the system nearly everywhere except in central Berkeley and Dorchester Counties. This permeability is particularly marked in the outcrop/subcrop area of Berkeley and Charleston Counties where the very pure limestone has been weathered by circulating meteoric ground water. The permeability of the upper zones generally decreases in areas south of the outcrop area where the limestone is overlain by the Cooper Formation. Water-bearing zones also occur within the lower 50 to 150 ft of the aquifer system in southern Charleston and Dorchester Counties and are most productive in western Dorchester County and southernmost Charleston County. By contrast, permeability development is negligible in a large area surrounding Summerville and Goose Creek, where a combination of faulting (?) and relatively impure limestone may have hampered ground-water flow and the dissolution of the aquifer material.

The permeability of the Santee Limestone is low in comparison with the underlying Black Mingo Formation and with limestones in the counties to the south of the study area. Consequently, well yields are modest and, typically, will not exceed 300 gpm without causing more than 100 ft of drawdown in the well. However, yields are usually sufficient to supply domestic and light industrial needs. Wells in the outcrop areas east of Moncks Corner are between 30 and 100 ft in depth, and yields of up to 300 gpm are reported locally. Similar yields can be obtained from individual 200- to 450-ft wells in central and southern Charleston County and adjacent parts of Berkeley and Dorchester Counties. Permeabilities appear to be lowest in the central part of the study area, between Goose Creek and Summerville, where domestic wells have specific capacities of less than 2 gpm/ft and "dry holes" are reported locally.

of the study and is partially due to the very low permeability that occurs in this part of the study area.

Water level declines have also occurred in the vicinity of a limestone quarry located 2 miles east of Jamestown in Berkeley County. During 1978 the quarry withdrew as much as 36 mgd from the Santee Limestone to permit dry mining for road aggregate and agricultural lime. Until the operation reduced its pumping, water levels in the quarry frequently fell below sea level, spring-fed Dutart Creek dried up, and nearby property owners experienced problems with well-water supplies and sinkholes. The sinkholes ranged up to 25 ft in diameter and formed as a result of frequent water-level flucuations in the quarry and loading or vibrations caused by rainfall and the passage of heavy equipment. Although there were no personal injuries resulting from sinkhole collapses, collapses did occur on rights of way, adjacent to houses, and in cultivated fields near the quarry.

Cooper Formation

The Cooper Formation is significant as a hydrologic unit mainly by virtue of its impermeability. In most localities, its sandy, finely granular limestones produce little or no water, but instead act as confining material that causes artesian conditions in the underlying Santee Limestone. Only a few feet of the formation need to be present to effectively retard the vertical movement of ground water. The Charleston Public Works Department has taken advantage of this impermeability by boring a 5-foot diameter, 23-mile-long unlined tunnel through the Cooper Formation from the Edisto River at Givhans to their treatment plant at Hanahan.

Locally, permeable zones exist within the Cooper. A number of drilling logs report penetrating thin, soft, water-bearing limestone beds at depths of −200 to −250 ft msl in the vicinity of Edisto Island; whether they contribute significant amounts of water is not known.

A more noteworthy water-bearing zone occurs in the vicinity of Ravenel in southern Charleston County. There, a porous bryozoan limestone occurs between approximately −50 ft and −90 ft msl and is reported to yield as much as 300 gpm to some wells. The limestone is easily distinguished in gamma-ray logs as a zone of very low gamma-ray intensity sandwiched between the high gamma-ray intensity of limestone of the Ashley and Parkers Ferry Members. Although the unit is 30 to 40 ft thick at Ravenel, it pinches out only a few miles east, south, and west of the town limit, and apparently it extends no more than 10 or 12 miles to the north. Because the unit is limited to a small area and is overlain by a 30- to 40-ft confining unit that inhibits recharge, it may not be a reliable source of ground water for users such as public supply systems or industries.

Shallow Aquifers

The shallow aquifers encompass all rocks younger than the Cooper Formation; they include the Hawthorn Formation, Edisto Formation, and Pleistocene terrace deposits. South of latitude 33°12′00″, they directly overlie the Cooper, and elsewhere they overlie the Black Mingo Formation or Santee Limestone. In most areas, the shallow aquifers consist of discontinuous layers of sand, clay, and locally occurring beds of shell and limestone. The thickest sequence occurs in Charleston County where the base of the shallow aquifers lies 40 to 65 ft below land surface. Elsewhere, their thickness is generally less than 30 ft.

For most parts of the study area, ground water in the shallow aquifers occurs under water-table conditions. Although the shallow system locally may receive some recharge from the underlying Santee Limestone, most recharge is supplied by local rainfall. The water moves by gravity from areas of high elevation to areas of low elevation at a rate that depends on the slope of the water table and the permeability of the aquifer. Reported water levels are commonly 3 to 15 ft below land surface and, in part, reflect variations in the local topography. In general, water levels lie at greatest depth in areas of high elevation and are near land surface where elevations are low. Swampy areas result where the water table is at or very near the land surface much of the time.

The water table rises and falls in response to fluctuations in rainfall, seasonal variations in the rate of evapotranspiration, the topography, and the hydraulic characteristics of the aquifer. Typical water level changes in the area are on the order of 1 to 6 ft within a year. Figure 27 shows the fluctuations in water level in a shallow well, unaffected by pumping, at Edisto Island from May 1981 to January 1983. The minimum water levels occurred during November and December and coincided with a period of slight rainfall; during the following months the level recovered nearly 3 ft in response to increasing amounts of precipitation during a period of low rates of evapotranspiration.

Discharge from the shallow aquifers occurs as a result of pumping for domestic, irrigation, and industrial uses; natural seepage into lakes and streams; loss to evapotranspiration; and downward movement into underlying aquifers. Natural seepage and evapotranspiration are the principal means of discharge, since shallow wells account for only small amounts of water lost from the system, and the underlying Cooper Formation inhibits downward leakage where it occurs. However, downward leakage is a significant means of discharge where the Cooper is absent and the shallow system is underlain by the Santee Limestone and Black Mingo. As shown in Figure 28, water levels in shallow wells and Black Mingo wells near St. Stephen have a similar response to rainfall. Water levels in well 18W-a7 are slighly higher than in Black Mingo well 18W-a6, indicating that the shallow water has some head and can move downward. The sharp decline during 1980 and 1981 is the result of dewatering during construction of a power plant at the Santee River rediversional canal.

Shallow wells are used in all parts of the study area, but they are most common in Charleston County where the shallow system is thickest and most permeable and where water quality in the underlying formations is poor. In much of the area near the coast and south of Mt. Pleasant,

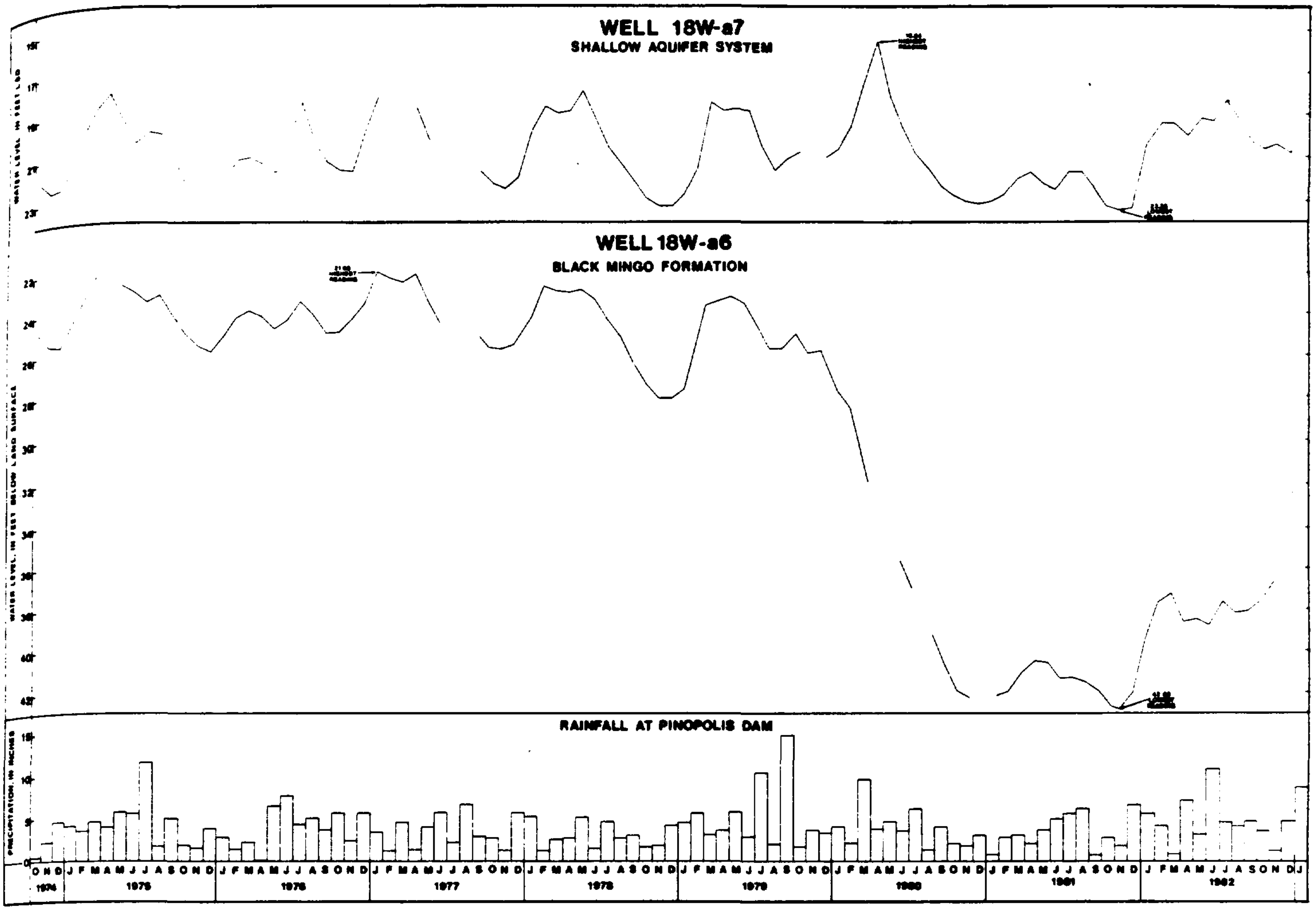

Figure 28. Hydrograph of observation wells 18W-a6 and 18W-a7, near St. Stephen.

the shallow system is the only economical source of fresh ground water for domestic users. The shallow system also supplies small public water systems and is used at Mt. Pleasant, Isle of Palms, Sullivans Island, and Edisto Beach to dilute high-fluoride water from the Black Creek Formation or Santee Limestone.

Although at least 10 gpm can be obtained from the shallow aquifers in nearly all parts of Charleston County, the same is not true for Berkeley and Dorchester Counties. Locally, the shallow sand beds are thin or contain high percentages of clay and silt. Consequently, wells must be drilled into the Santee Limestone and Black Mingo aquifers. The limestone is also a preferred source of ground water in its outcrop areas, where an open-hole well in the limestone may be constructed as economically as a shallow, screened well.

The thickness and permeability of the shallow aquifers vary greatly, even within a small area, so the quantity of water produced by individual wells is likewise variable. Small-diameter domestic wells are usually equipped with jet pumps of less than 1 horsepower and produce about 8 gpm. Most municipal and industrial wells are 4 to 6 inches in diameter, have 15 to 30 ft of screen, and yield between 20 and 200 gpm. In a typical well field, such as those maintained by the Town of Mt. Pleasant, individual well yields range from 40 gpm, with a specific capacity of 1.3 gpm/ft, to175 gpm, with a specific capacity of 7 gpm/ft. Municipal well fields located on the barrier islands use 15- to 20-ft deep well-point systems which spread withdrawals over large areas but restrict the depth of pumping in order to avoid saltwater intrusion or upconing.

The transmissivities of the shallow aquifers are assumed to be relatively low since the system averages less than 40 ft in thickness, commonly consists of fine-grained or poorly sorted sand, and reported specific capacities are generally less than 4 gpm/ft. An aquifer test at Edisto Island indicated a transmissivity of about 600 ft^2/day (J.T. Johnson, 1981). The saturated thickness of the aquifer was 45 ft, indicating a hydraulic conductivity of 13 ft/day. Discharge during the test was 32 gpm and water-level measurements were taken in the pumping well and two observation wells over a period of 30 hours.

WATER USE

The 1980 water use information presented in Table 3 was assembled from the files of the SCWRC and represents data collected as part of a statewide cooperative program with the U.S. Geological Survey. Table 4 represents the projected use of both ground water and surface water by six categories of water users. Information on water use by public supply systems was obtained through the assistance of the S.C. Department of Health and Environmental Control. Agricultural use was obtained through agents of the U.S. Soil Conservation Service and the Clemson University Extension Service. Industrial water-use figures were obtained through the U.S. Department of Labor, which included SCWRC water-use questionnaires in its annual review of labor statistics. Water use by private households was determined on the basis of the number of persons who were not served by public water supply systems. The amounts of water used to generate electricity were obtained directly from the generation plants.

Public-supply water usage constitutes the second largest category of water use. Most of that water (65.7 mgd) was withdrawn from the Edisto River Basin and transferred into the Ashley and Cooper River Basins by the Charleston Commission of Public Works. About 33 percent of the water was distributed directly to private households; 1 mgd of raw water was sold to the Town of Summerville, which mixes surface water with water from wells tapping Middendorf and Black Creek aquifers; and the remaining water, both raw and treated, was sold to commercial and industrial concerns. Public-supply surface-water use is projected to increase by 44 percent between 1980 and 2000.

Fourteen public water systems were supplied by wells in 1980. These systems withdrew a total of 4.8 mgd in 1980 and are expected to be withdrawing more than 10 mgd by 2000. Withdrawals by Mt. Pleasant, Moncks Corner, Summerville, and Berkeley County Water and Sewer Authority constitute the bulk of public-supply ground-water use.

Rural domestic water users pumped an average of 8.6 mgd from ground water sources, and this use category represents the greatest amount of ground water withdrawal in the study area. Domestic water users are defined as rural and suburban homes not served by public water-supply systems and represent about 25 percent of the area's population. The domestic water use was computed by multiplying average daily per capita use (80 gpd) by the population not served by public water systems (107,153). Ground water use by this category is expected to remain relatively high, increasing by 92 percent to 16.5 mgd, by 2000.

Self-supplied industry used 17.2 mgd, 5.3 mgd of which was obtained from wells. Projected industrial ground water use for 2000 is 6.7 mgd.

Water use by farms in the area is relatively insignificant. The total amount of water used for livestock and irrigation was less than 1 mgd in 1980 and is projected to rise to only 3.2 mgd by 2000. About 70 percent of that increase, or 2.2 mgd, will be used for irrigation. Less than 800 acres of farmland were irrigated in 1980.

By far the largest withdrawals are made by thermoelectric power plants. Three plants withdrew a total of 372 mgd of surface water, of which 16 mgd was saline surface water. projected withdrawals for 2000 are 432 mgd. Nonwithdrawal use for hydroelectric power generation is not given in Table 3, but it averaged 10,000 mgd in 1980.

Table 3. Average water use, 1980, in million gallons per day.

COUNTY	MUNICIPAL	DOMESTIC	INDUSTRIAL	LIVESTOCK	IRRIGATION (ACRES)	THERMO-ELECTRIC	TOTAL
BERKELEY							
Ground water	0.834	5.572	2.245	0.040	0.130 (175)	—	8.821
Surface water	—	—	10.181	.050	.156 (210)	356.000	366.387
Total	.834	5.572	12.426	.090	.286 (385)	356.000	375.208
CHARLESTON							
Ground water	2.116	1.239	.844	.030	.222 (300)	—	4.451
Surface water	65.664	—	.018	.020	—	16.000 (saline)	81.702
Total	67.780	1.239	.862	.050	.222 (300)	16.000	86.153
DORCHESTER							
Ground water	1.772	1.760	2.236	.060	—	—	5.828
Surface water	—	—	1.710	.060	.060 (80)	—	1.830
Total	1.772	1.760	3.946	.120	.060 (80)	—	7.658
TOTAL							
Ground water	4.772	8.571	5.325	.130	.352 (475)	—	19.100
Surface water	65.664	—	11.909	.130	.216 (290)	372.000	449.919
Total	70.386	8.571	17.234	.260	.567 (765)	372.000	469.019

NUS CORPORATION AND SUBSIDI/ Reference No. 5 **ON NOTE**

CONTROL NO:	DATE:	TIME:
	September 23., 1987	0900

DISTRIBUTION:

Plant Site File

BETWEEN:	OF:	PHONE:
Harvey Wilkins	South Carolina Dept. of Health	(803) 554-5533

AND:

Carol Doran NUS Corporation CAD 10-1-87

DISCUSSION:

Summerville Water System

Summerville gets their water from both surface and groundwater sources. Summerville has a surface water treatment plant that gets its water from the Edisto River. Summerville also has 4 deep wells and is currently drilling a 5th well. Mr. Wilkins knows that the wells are at least 1000 feet deep or greater but does not know exact depth or location of these wells. Summerville also gets some water from the city of Charleston.

Additionally, the Dorchester County Water Authority has several groundwater well systems in the area.

ACTION ITEMS:

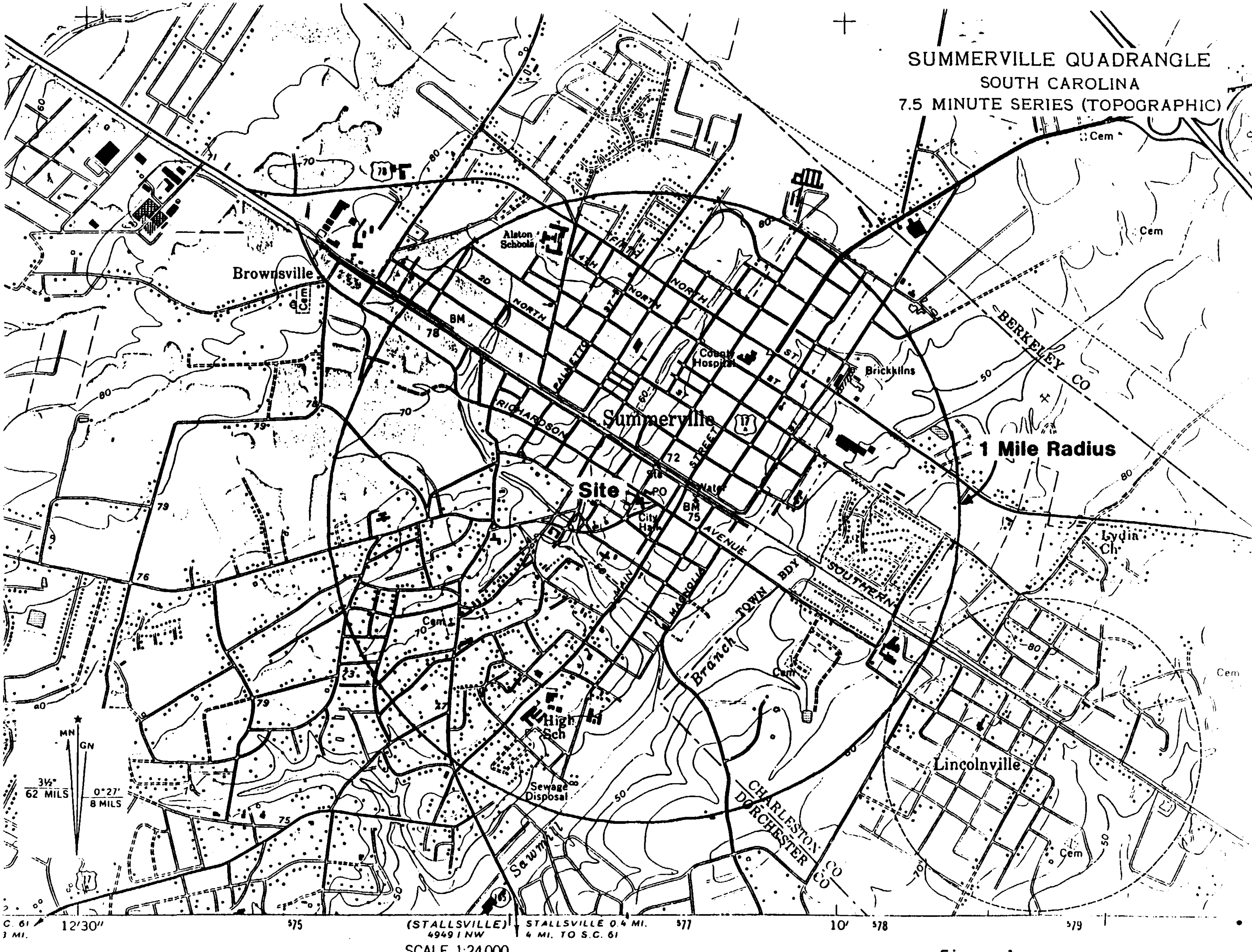
SUMMERVILLE QUADRANGLE
SOUTH CAROLINA
7.5 MINUTE SERIES (TOPOGRAPHIC)
1 Mile Radius
Site
Summerville
Brownsville
Lincolnville
Alston Schools
County Hospital
Brickkilns
City Hall
PO
High Sch
Sewage Disposal
Lydia Ch
Cem
BERKELEY CO
CHARLESTON CO
DORCHESTER CO
RICHARDSON
MAIN
MAGNOLIA
AVENUE
SOUTHERN
TOWN BDY
Branch
Sawmill
NORTH
FIFTH
(STALLSVILLE)
4949 I NW
STALLSVILLE 0.4 MI.
4 MI. TO S.C. 61
12'30"
10'
SCALE 1:24000

Figure 1

OVERSIZED

DOCUMENT

NUS CORPORATION

1927 LAKESIDE PARKWAY
SUITE 614
TUCKER, GEORGIA 30084
404-938-7710

C-586-9-7-92

September 18, 1987

Mr. Robert Jourdan
Site Investigation and Support Branch
Waste Management Division
Environmental Protection Agency
345 Courtland Street, N. E.
Atlanta, Georgia 30365

Subject: Preliminary Assessment
Plant Site [redacted]
Summerville, South Carolina
TDD No. F4-8709-39
EPA ID No. **SCD 061525192**

Dear Mr. Jourdan:

Enclosed please find two copies of the revised Preliminary Assessment for the above referenced site. More information on this site will be provided at a later date.

If you have any questions, please contact me at NUS Corporation.

Very truly yours,

Carol A. Doran

Carol A. Doran

Approved:

CAD/mb

Enclosure

cc: Scott Gardner

Not in WASTELAN -
As "PLANT SITE" -
It's EXXON CHEMICAL
COMPANY / SUMMER*
HWY 78 W
Summerville, SC
29483

Type in parentheses (Exxon Chemical Co./ Summerville Dump) next to Plant Site

Exxon Chemical Co./Summerville Dump

(PLANT SITE)
SCD061525192
PRELIMINARY ASSESSMENT

A. **Site Description:** The Plant Site is located on Highway 78W, Summerville, Dorchester County, South Carolina (1) (Figure 1).

B. **Description of Hazardous Conditions, Incidents and Permit Violations:** The Plant Site consists of 25,000 pounds of yarn buried at the site on a one time basis. The yarn had trace amounts of mercury and cadmium (1).

C. **Nature of Hazardous Materials:** Cadmium affects the lungs and kidneys (2). Mercury has an adverse effect on the central nervous system (2).

D. **Routes of Contamination:** Since wastes were buried, there is a potential for groundwater contamination.

E. **Possible Affected Population and Resources:** In the Summerville area, the surficial aquifer is less than 30 feet thick. The surficial aquifer is underlain by the Cooper Marl, which is 170 feet thick in this area. The Cooper Marl is extremely impermeable. Only a few feet of this formation need be present to effectively retard the vertical movement of groundwater (4). The Cooper Marl is underlain by at least five aquifers of varying productivity (4).

The thin surficial aquifer produces very little water in the Summerville area. Wells must be drilled through the impermeable Cooper Marl to encounter producible amounts of groundwater for domestic use (4).

The City of Summerville uses a mix of surface water (from their own treatment plant and water bought from Charleston) and groundwater. The majority of their water comes from their own wells (3,4,5). Summerville has five wells located throughout the city. These wells average 1,840 feet in depth (3,5). The Summerville wells produce from the sand layers of the Middendorf and Black Creek formations. The screened internal for these wells is between 1,600 and 1,700 feet (4).

Information concerning the exact location of these wells is unavailable.

F. **Recommendations and Justification**: Since the buried yarn contained only trace amounts of contaminants, and the aquifers used in the area are overlain by an impermeable Marl 170 feet thick, a priority for site investigation of none is recommended [1,4].

References

1. USEPA Potential Hazardous Waste Site Identification and Preliminary Assessment for Plant Site, Summerville, Dorchester County, South Carolina. 3/31/81.

2. Kirk-Othmer. 1981. Encyclopedia of Chemical Technology. John Wiley & Sons, N.Y. pp. 264-270.

3. Doran, C. to File, 9/14/87. Conversation record with Mr. Reynolds about the water system of Summerville, South Carolina.

4. Park, A. 1985. The Ground-Water Resources of Charleston, Berkeley, and Dorchester Counties, South Carolina. State of South Carolina Water Resources Commission Report No. 139. 145 p.

5. Doran, C. to File, 9/23/87. Conversation record with Mr. Wilkins about the water system of Summerville, South Carolina.

SITE DISCOVERY FORM

Part 1: Information necessary to add a site to CERCLIS

ACTION: A

EPA ID: SCD061525192

SITE NAME: Plant Site (Exxon Chemical Company) SOURCE: R (R=EPA, T=STATE

STREET: Highway 78 W CONG DIST: 01 (optional)

CITY: Summerville ZIP: 29483 - ____

CNTY NAME: Dorchester CNTY CODE: 035 (optional)

LATITUDE: 33 / 01 / 06.0 LONGITUDE: 080 / 10 / 42.0 (optional)

INVENTORY IND: Y REMEDIAL IND: Y REMOVAL IND: N FED FAC IND: N

RPM NAME: Scott Gardner RPM PHONE: 404 - 347 - 2234 (EPA Project Offic

SITE DESCRIPTION: (optional)

25,000 pounds of yarn were buried at the site. The yarn did have trace amounts of mercury and cadmium. The majority of the waste, however, had no mercury or cadmium.

Part 2: Other site information

DATE SITE FIRST REPORTED: __ / __ / __ REPORTED BY: ____

REASON FOR LISTING: ____

873-5800

POTENTIAL HAZARDOUS WASTE SITE IDENTIFICATION AND PRELIMINARY ASSESSMENT

REGION | SITE NUMBER (to be assigned by Hq): 2695

NOTE: This form is completed for each potential hazardous waste site to help set priorities for site inspection. The information submitted on this form is based on available records and may be updated on subsequent forms as a result of additional inquiries and onsite inspections.

GENERAL INSTRUCTIONS: Complete Sections I and III through X as completely as possible before Section II (Preliminary Assessment). File this form in the Regional Hazardous Waste Log File and submit a copy to: U.S. Environmental Protection Agency; Site Tracking System; Hazardous Waste Enforcement Task Force (EN-335); 401 M St., SW; Washington, DC 20460.

I. SITE IDENTIFICATION

A. SITE NAME: EXXON CHEMICAL COMPANY (PLANT SITE)

B. STREET (or other identifier): HWY 78 W

C. CITY: SUMMERVILLE

D. STATE: SC

E. ZIP CODE: 29483

F. COUNTY NAME: Dorchester

G. OWNER/OPERATOR (if known)

1. NAME: Same as Above

2. TELEPHONE NUMBER: 873-5800

H. TYPE OF OWNERSHIP

☐ 1. FEDERAL ☐ 2. STATE ☐ 3 COUNTY ☐ 4 MUNICIPAL ☒ 5 PRIVATE ☐ 6 UNKNOWN

I. SITE DESCRIPTION

a hole was dug & waste put in it

J. HOW IDENTIFIED (i.e., citizen's complaints, OSHA citations, etc.)

K. DATE IDENTIFIED (mo., day, & yr.)

L. PRINCIPAL STATE CONTACT

1. NAME: John V. Ullard

2. TELEPHONE NUMBER: 722-2962

II. PRELIMINARY ASSESSMENT (complete this section last)

A. APPARENT SERIOUSNESS OF PROBLEM

☐ 1. HIGH ☐ 2. MEDIUM ☐ 3 LOW ☐ 4 NONE ■ 5. UNKNOWN

See Page 4

B. RECOMMENDATION

☐ 1. NO ACTION NEEDED (no hazard)

☐ 2. IMMEDIATE SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 3. SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 4. SITE INSPECTION NEEDED (low priority)

C. PREPARER INFORMATION

1. NAME: John V. Ullard

2. TELEPHONE NUMBER: 722-2962

3. DATE (mo., day, & yr.): 3/31/81

III. SITE INFORMATION

A. SITE STATUS

☐ 1. ACTIVE (Those industrial or municipal sites which are being used for waste treatment, storage, or disposal on a continuing basis, even if infrequently.)

☒ 2. INACTIVE (Those sites which no longer receive wastes.)

☐ 3. OTHER (specify): (Those sites that include such incidents like "midnight dumping" where no regular or continuing use of the site for waste disposal has occurred.)

B. IS GENERATOR ON SITE?

☐ 1. NO ☐ 2. YES (specify generator's four-digit SIC Code):

C. AREA OF SITE (in acres)

D. IF APPARENT SERIOUSNESS OF SITE IS HIGH, SPECIFY COORDINATES

1. LATITUDE (deg.—min.—sec.)

2. LONGITUDE (deg.—min.—sec.)

E. ARE THERE BUILDINGS ON THE SITE?

☐ 1. NO ☐ 2. YES (specify):

Continued From Front

V. CHARACTERIZATION OF SITE ACTIVITY

Indicate the major site activity(ies) and details relating to each activity by marking 'X' in the appropriate boxes.

'X'	A. TRANSPORTER	'X'	B. STORER	'X'	C. TREATER	'X'	D. DISPOSER
	1. RAIL		1. PILE		1. FILTRATION		1. LANDFILL
	2. SHIP		2. SURFACE IMPOUNDMENT		2. INCINERATION		2. LANDFARM
	3. BARGE		3. DRUMS		3. VOLUME REDUCTION		3. OPEN DUMP
	4. TRUCK		4. TANK, ABOVE GROUND		4. RECYCLING/RECOVERY		4. SURFACE IMPOUNDMENT
	5. PIPELINE		5. TANK, BELOW GROUND		5. CHEM./PHYS. TREATMENT		5. MIDNIGHT DUMPING
	6. OTHER (specify):		6. OTHER (specify):		6. BIOLOGICAL TREATMENT		6. INCINERATION
					7. WASTE OIL REPROCESSING		7. UNDERGROUND INJECTION
					8. SOLVENT RECOVERY		8. OTHER (specify): open wastes on the dump
					9. OTHER (specify):		

E. SPECIFY DETAILS OF SITE ACTIVITIES AS NEEDED

V. WASTE RELATED INFORMATION

A. WASTE TYPE

☐ 1 UNKNOWN ☐ 2 LIQUID ☒ 3. SOLID ☐ 4. SLUDGE ☐ 5. GAS

B. WASTE CHARACTERISTICS

☐ 1 UNKNOWN ☐ 2. CORROSIVE ☐ 3. IGNITABLE ☐ 4 RADIOACTIVE ☐ 5 HIGHLY VOLATILE
☐ 6 TOXIC ☐ 7 REACTIVE ☒ 8 INERT ☐ 9 FLAMMABLE

☐ 10 OTHER (specify):

C. WASTE CATEGORIES

1. Are records of wastes available? Specify items such as manifests, inventories, etc. below.

2. Estimate the amount (specify unit of measure) of waste by category; mark 'X' to indicate which wastes are present.

a. SLUDGE	b. OIL	c. SOLVENTS	d. CHEMICALS	e. SOLIDS	f. OTHER
AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT
UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE
'X' (1) PAINT, PIGMENTS	'X' (1) OILY WASTES	'X' (1) HALOGENATED SOLVENTS	'X' (1) ACIDS	'X' (1) FLYASH	'X' (1) LABORATORY PHARMACEUT.
(2) METALS SLUDGES	(2) OTHER (specify):	(2) NON-HALOGNTD. SOLVENTS	(2) PICKLING LIQUORS	(2) ASBESTOS	(2) HOSPITAL
(3) POTW		(3) OTHER (specify):	(3) CAUSTICS	(3) MILLING/MINE TAILINGS	(3) RADIOACTIVE
(4) ALUMINUM SLUDGE			(4) PESTICIDES	(4) FERROUS SMLTG. WASTES	(4) MUNICIPAL
(5) OTHER (specify):			(5) DYES/INKS	(5) NON-FERROUS SMLTG. WASTES	(5) OTHER (specify):
			(6) CYANIDE	(6) OTHER (specify):	
			(7) PHENOLS		
			(8) HALOGENS		
			(9) PCB		
			(10) METALS		
			(11) OTHER (specify)		

 Continue On Page 3

Continued From Page 2

V. WASTE RELATED INFORMATION (continued)

3. LIST SUBSTANCES OF GREATEST CONCERN WHICH MAY BE ON THE SITE (place in descending order of hazard).

4. ADDITIONAL COMMENTS OR NARRATIVE DESCRIPTION OF SITUATION KNOWN OR REPORTED TO EXIST AT THE SITE.

VI. HAZARD DESCRIPTION

A. TYPE OF HAZARD	B. POTENTIAL HAZARD (mark 'X')	C. ALLEGED INCIDENT (mark 'X')	D. DATE OF INCIDENT (mo.,day,yr.)	E. REMARKS
1. NO HAZARD				
2. HUMAN HEALTH				
3. NON-WORKER INJURY/EXPOSURE				
4. WORKER INJURY				
5. CONTAMINATION OF WATER SUPPLY				
6. CONTAMINATION OF FOOD CHAIN				
7. CONTAMINATION OF GROUND WATER				
8. CONTAMINATION OF SURFACE WATER				
9. DAMAGE TO FLORA/FAUNA				
10. FISH KILL				
11. CONTAMINATION OF AIR				
12. NOTICEABLE ODORS				
13. CONTAMINATION OF SOIL				
14. PROPERTY DAMAGE				
15. FIRE OR EXPLOSION				
16. SPILLS/LEAKING CONTAINERS/ RUNOFF/STANDING LIQUIDS				
17. SEWER, STORM DRAIN PROBLEMS				
18. EROSION PROBLEMS				
19. INADEQUATE SECURITY				
20. INCOMPATIBLE WASTES				
21. MIDNIGHT DUMPING				
22. OTHER (specify):				

 Continue On Reverse

Continued From Front

VII. PERMIT INFORMATION

A. INDICATE ALL APPLICABLE PERMITS HELD BY THE SITE.

☐ 1. NPDES PERMIT ☐ 2. SPCC PLAN ☐ 3. STATE PERMIT *(specify)*:
☐ 4. AIR PERMITS ☐ 5. LOCAL PERMIT ☐ 6. RCRA TRANSPORTER
☐ 7. RCRA STORER ☐ 8. RCRA TREATER ☐ 9. RCRA DISPOSER
☐ 10. OTHER *(specify)*:

B. IN COMPLIANCE?

☐ 1. YES ☐ 2. NO ☐ 3. UNKNOWN

4. WITH RESPECT TO *(list regulation name & number)*:

VIII. PAST REGULATORY ACTIONS

☐ A. NONE ☐ B. YES *(summarize below)*

IX. INSPECTION ACTIVITY *(past or on-going)*

☐ A. NONE ☐ B. YES *(complete items 1,2,3, & 4 below)*

1. TYPE OF ACTIVITY	2. DATE OF PAST ACTION (mo., day, & yr.)	3. PERFORMED BY: (EPA/State)	4. DESCRIPTION

X. REMEDIAL ACTIVITY *(past or on-going)*

☐ A. NONE ☐ B. YES *(complete items 1, 2, 3, & 4 below)*

1. TYPE OF ACTIVITY	2. DATE OF PAST ACTION (mo., day, & yr.)	3. PERFORMED BY: (EPA/State)	4. DESCRIPTION

NOTE: Based on the information in Sections III through X, fill out the Preliminary Assessment *(Section II)* information on the first page of this form.

I spoke with Mr. Jim Nichols, Plant Engineer on 3/31/81. He stated that only on a one time basis they disposed of 25,000 pounds of yarn on the site and covered it with earth. A letter from Mr. Dick Swanson of Exxon to Mr. Charles Kelly confirm apparently that they had approval. A very small part of the yarn did have mercury and cadmium in it in trace amounts, how[ever] Mr. Nichols stated that "the poly substrate ties up these heavy metals when no sunlight hits them and the waste is buried." He also sta[ted] that it would be impossible to pull a representative sample because a large part of the waste had no mercury or cadmium.

Reference No. 2

KIRK-OTHMER

ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

THIRD EDITION

VOLUME 13

HYDROGEN-ION ACTIVITY
TO
LAMINATED MATERIALS, GLASS

A WILEY-INTERSCIENCE PUBLICATION
John Wiley & Sons
NEW YORK • CHICHESTER • BRISBANE • TORONTO

1981

Table 1 (*continued*)

Substance	CAS Registry Number	Current OSHA environmental standard	NIOSH recommendation for environmental exposure limit[b]	Health effect considered	Comments
benzene	[71-43-2]	10-ppm, 8-h TWA; 25-ppm acceptable ceiling; 50-ppm maximum ceiling (10-min)[d]	1-ppm ceiling (3.2 mg/m³) (60-min)	blood changes including leukemia	blood testing required
benzoyl peroxide	[94-36-0]	5-mg/m³, 8-h TWA	5 mg/m³ TWA	airway and eye irritation, skin effects	
benzyl chloride	[100-44-7]	1-ppm (5 mg/m³), 8-h TWA	5 mg/m³ ceiling (15-min)	irritation; skin and eye effects	chest x-ray and pulmonary function testing required
beryllium	[7440-41-7]	2 μm/m³, 8-h TWA; 5-μm/m³, acceptable ceiling; 25 μm/m³ maximum ceiling (30-min)	0.5 μm/m³ (130-min)	lung cancer	pulmonary function chest x-ray, and sputum cytology required
boron trifluoride	[7637-07-2]	1-ppm ceiling	none recommended	respiratory system effects	adequate procedures for sampling and analysis not available; pulmonary function testing required
cadmium	[7440-43-9]	0.1 mg/m³, 8-h TWA; 0.3 mg/m³ ceiling (fume; erroneously published as 3 mg/m³) 0.2 mg/m³, 8-h TWA; 0.6 mg/m³ ceiling (dust)	40 μm CD/m³, TWA; 200 μm CD/m³ ceiling (15-min)	lung and kidney effects	urine and pulmonary function testing required
carbaryl	[63-25-2]	5 mg/m³, 8-h TWA	5 mg/m³, TWA	nervous and reproductive system effects	medical warnings of possible effects on reproductive system and minimum exposure during pregnancy required; skin and eye contact to be prevented
carbon black	[1333-86-4]	3.5 mg/m³, 8-h TWA	3.5 mg/m³ TWA; 0.1 mg/m³ TWA in presence of polycyclic aromatic hydrocarbons	lung, heart, and skin effects; cancer	chest x-rays, pulmonary function testing, ECG, and sputum cytology required
carbon dioxide	[124-38-9]	5000-ppm, 8-h TWA	10,000-ppm TWA (18,000 mg/m³) 30,000-ppm ceiling (54,000 mg/m³) (10-min)	respiratory effects	
carbon disulfide	[75-15-0]	20-ppm, 8-h TWA; 30-ppm acceptable ceiling; 100-ppm maximum ceiling	1-ppm TWA (3 mg/m³); 10-ppm ceiling (30 mg/m³) (15-min)	heart, nervous, and reproductive system effects	employees to be advised of potential effects on reproductive system
carbon monoxide	[630-08-0]	50-ppm, 8-h TWA	35-ppm TWA (40 mg/m³); 200-ppm ceiling (229 mg/m³)	heart effects	

Table 1 (*continued*)

Substance	CAS Registry Number	Current OSHA environmental standard	NIOSH recommendation for environmental exposure limit[b]	Health effect considered	Comments
malathion	[121-75-5]	15 mg/m³, 8-h TWA	15 mg/m³ TWA	nervous system effects	skin contact to be prevented; blood monitoring required
mercury, inorganic	[7439-97-6]	0.1 mg/m³ ceiling	0.05 mg/m³ TWA	central nervous system and mental effects	
methyl alcohol	[67-56-1]	200-ppm TWA	200-ppm TWA (262 mg/m³); 800-ppm ceiling (1048 mg/m³) (15-min)	blindness; metabolic acidosis	
4,4′-methylene-bis(2-chloro-aniline[e]	[101-14-4]	none—standard remanded by court	3 μm/m³ TWA; skin contact to be avoided	cancer	chest x-ray, blood and urine testing required
methyl parathion	[298-00-0]	none	0.2 mg/m³ TWA	nervous system effects	skin contact to be prevented; blood monitoring required
methylene chloride	[75-09-2]	500-ppm, 8-h TWA; 1000-ppm acceptable ceiling; 2000-ppm maximum (5-min in 2 h)	75-ppm TWA (261 mg/m³); 500-ppm ceiling (1740 mg/m³) to be lowered in presence of carbon monoxide	central nervous system effects; carbon monoxide toxicity	blood monitoring required
nickel carbonyl[c]	[13463-39-3]	7 μm/m³ (1-ppb), 8-h TWA	7 μm/m³ (1-ppb) TWA	cancer	recommendations for chest x-ray, pulmonary function, and urine monitoring
nickel, inorganic and compounds	[7440-02-0]	1 mg/m³, 8-h TWA	15 μm Ni/m³ TWA	skin effects; lung and nasal cancer	chest x-ray and pulmonary function testing required
nitric acid	[7697-37-2]	2-ppm, 8-h TWA	2-ppm TWA (5 mg/m³)	dental erosion, nasal/lung irritation	hazardous liquid, eyes and skin, chest x-ray required
nitriles	[75-05-8] [3333-52-6] [78-82-0] [107-12-0] [111-69-3] [110-61-2] [75-86-5] [107-16-4]	70 mg/m³ (40-ppm), 8-h TWA (acetonitrile); 3 mg/m³, (0.5-ppm), 8-h TWA, (skin) (tetramethylsuccinonitrile)	to be TWA values: acetonitrile: 34 mg/m³ (20-ppm); *N*-butyronitrile [109-74-0]: 22 mg/m³ (8-ppm); isobutyronitrile: 22 mg/m³ (8-ppm); propionitrile: 14 mg/m³ (6-ppm); malononitrile: 8 mg/m³ (3-ppm); adiponitrile: 18 mg/m³ (4-ppm); succinonitrile: 20 mg/m³ (6-ppm) to be ceiling values (15-min): acetone cyanohydrin: 4 mg/m³ (1-ppm); glycolonitrile: 5 mg/m³ (2-ppm); tetramethyl-succinonitrile: 6 mg/m³ (1-	hepatic, renal, respiratory, cardiovascular, gastrointestinal and nervous system effects	chest x-ray and pulmonary function testing required; trained personnel and first-aid kits to be available during use; hazardous substances, skin and eyes

NUS CORPORATION AND SUBSIDIARIES — *TELECON NOTE*

CONTROL NO:	DATE:	TIME:
	September 14, 1987	1515

DISTRIBUTION:
Plant Site File

BETWEEN:	OF:	PHONE:
Mr. Reynolds	Public Works, Summerville, S. Carolina	(803) 875-8757

AND:
Carol Doran, NUS Corporation CAD 9/14/87

DISCUSSION:

Re: Water System of Summerville

The City of Summerville uses a mix of surface water (from their own treatment plant and water bought from Charleston) and groundwater. The majority of their water comes from their own wells. The wells are 1840 feet deep. The wells are scattered over a large portion of Summerville.

Mr. Reynolds declined to provide anymore information at this point and requested that a list of questions be sent to him so that he could respond in writing.

ACTION ITEMS:

THE GROUND-WATER RESOURCES OF CHARLESTON, BERKELEY, AND DORCHESTER COUNTIES SOUTH CAROLINA

by
A. Drennan Park

**Prepared in cooperation with the
United States Geological Survey
and the
Coastal Plains Regional Commission**

STATE OF SOUTH CAROLINA

**WATER RESOURCES COMMISSION
REPORT NUMBER 139**

1985

ACKNOWLEDGEMENTS

The author wishes to express his thanks to the staff members of the South Carolina Water Resources Commission and USGS for their advice and efforts on behalf of this report. Particular thanks are due Mr. Rodney Cherry, District Chief, USGS, for his support during the project, and to the Coastal Plains Regional Commission, which provided much of the project funding.

The author is also indebted to the staffs of the many public works agencies and the consulting engineers who serve them. Special thanks are also extended to the G.W. Ackerman Well Company and T.A. Clyde Well Drilling for their assistance in obtaining drill samples, geophysical logs, and well-construction data.

GEOLOGIC FRAMEWORK

The rock units underlying Charleston, Berkeley, and Dorchester Counties represent a broad range of lithologies, depositional environments, and ages (Table 1). The oldest units, the Middendorf, Black Creek, and Peedee Formations, are of Late Cretaceous age and were deposited in environments ranging from continental to innershelf marine. Their lithologies are predominantly clastic, consisting of sand, silt, and clay. The bulk of the units overlying the Late Cretaceous formations consists of the Tertiary Black Mingo Formation, Santee Limestone, and Cooper Formation. These units are the result of deposition in marine environments ranging from marginal marine to outer shelf. Sand, silt, and clay dominate the

Table 1. Stratigraphic units and their water-bearing characteristics.

SYSTEM	SERIES	FORMATION	LITHOLOGY	WATER-BEARING CHARACTERISTICS
Quaternary	Holocene and Pleistocene	Terrace Deposits	Highly variable. Light-colored fine-to medium-grained sands, shelly sands, and shell beds; varicolored clays. Locally coarse-grained sand or gravel; thin limestone beds.	Ground water occurs under water-table or poorly confined conditions. Transmissivities are generally less than 1,000 ft²/day. Well yields are variable, ranging from 0 to 200 gpm. Water is commonly acidic at shallow depths and high in iron.
	Miocene	Hawthorn	Fine, sandy, phosphatic limestone, and thin remnents of sand and clay. Generally absent from study area.	
		Edisto	Pale-yellow, sandy, fossiliferous limestone. Present to the northwest along the Edisto River.	
Tertiary	Oligocene	Cooper	Pale-green, or yellowish-gray to olive-brown, sandy, phosphatic limestone. *Harleyville Member:* phosphatic, calcareous clay to clayey, very fine-grained limestone. *Parkers Ferry Member:* glauconitic, clayey, fine-grained, abundantly fossiliferous limestone. *Ashley Member:* phosphatic, muddy, calcareous sands.	Confining unit. Porous bryozoan limestone unit of limited extent will yield up to 300 gpm of freshwater. Yields unknown quantities of brackish water in southern Charleston County.
	Eocene	Santee Limestone	Creamy-white to gray, fossiliferous, locally phosphatic limestone. *Moultrie Member:* biosparrites and bryozoan hash. *Cross Member:* brachiopod-bivalve biomicrite.	Artesian, except in outcrop areas. Typically yields less than 300 gpm. Calcium bicarbonate type water with iron commonly in excess of 0.3 mg/L. Contains brackish water along coast.
Tertiary	Paleocene	Black Mingo	Fossiliferous, white to pale gray limestones, green to gray argillaceous sands, carbonate-and silica-cemented sandstones, and dark-gray to black clays.	Artesian. Transmissivities range from 500 to 8,500 ft²/day. Will yield 300 to 500 gpm in most areas. Water is soft, alkaline, sodium bicarbonate type. Locally, contains high fluoride and brackish water.
		Peedee	Olive-to-medium gray, fossiliferous, muddy sands and olive-to-medium gray, silty and sandy calcareous clays.	Artesian. Poor aquifer, yielding less than 300 gpm. Very mineralized sodium bicarbonate type water with high concentrations of fluoride. Contains brackish water along coast.
Cretaceous	Upper Cretaceous	Black Creek	Gray to gray-green muddy sands, silty clays, fine-to-medium grained white to gray sands, and shelly limestones with minor amounts of glauconite, phosphate, mica, and pyrite.	Artesian. Transmissivities range from 930 to 2,000 ft²/day. Yields 250 to 1,000 gpm. Water is soft, alkaline, sodium bicarbonate type. Fluoride exceeds 1.6 mg/L in eastern half of study area.
		Middendorf	Red, brown, and gray-green, poorly sorted feldspathic sands, and reddish or gray-green clay, silty clay, and clayey silt in lower half. Red, brown, yellow to olive-gray clay and silty clay, and greenish-gray, muddy, locally feldspathic sand in upper half.	Artesian. Transmissivities are probably less than 4,300 ft²/day in most areas. Yields range up to 2,000 gpm. Very mineralized, sodium bicarbonate type water. Fluoride concentrations up to 11 mg/L.
Triassic		Unnamed	Diabase, basalt, or quartzitic sandstone, depending on locality.	Hydraulic properties are unknown. Probably a poor source of water.

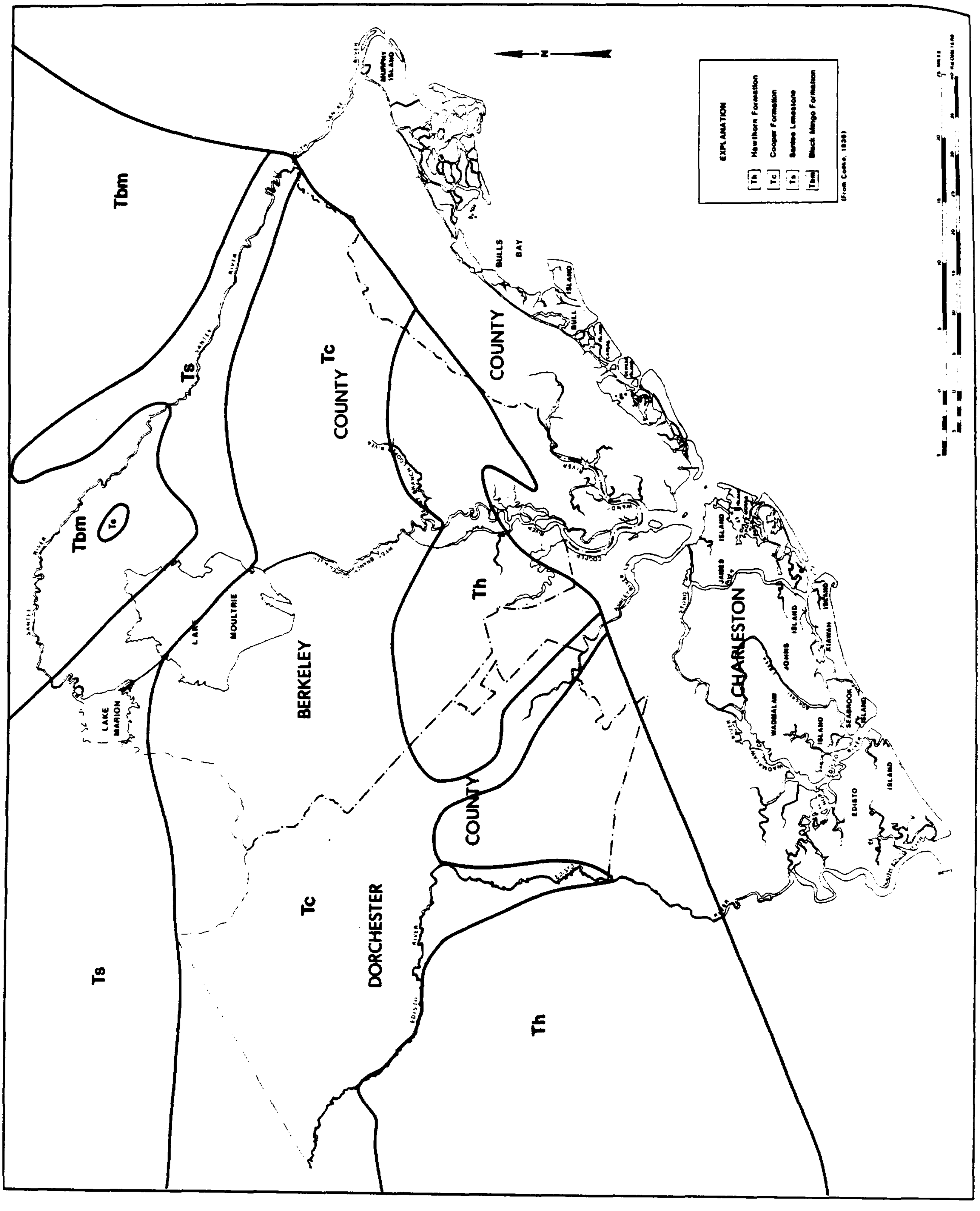

Figure 5. Generalized areal geology of Charleston, Berkeley, and Dorchester Counties.

lithology in the lower part of the Tertiary section, and pure to very impure limestone dominates the upper part. The major Tertiary units are in turn overlain by a shallow sequence of sand, silt, clay, and shell having an average thickness of less than 50 ft. Tertiary and Quaternary rocks are exposed at various locations, and the general distribution of their subcrop areas is shown in Figure 5.

The stratigraphic units that occur in the study area are part of a wedge of successively overlapping formations that thicken coastward from a feather edge at the fall line to about 3,000 ft at the southern extreme of Charleston County. Within the limits of the study area they have an average thickness of about 2,200 ft. The Late Cretaceous units lie at depths of 300 ft or more and crop out 30 to 70 miles north and west of the study area. Their occurrence is defined in cross section (Figs. 6, 7, 8, and 9).

Pre-Cretaceous Basement Rocks

Well-indurated sedimentary rocks and their metamorphic equivalents, volcanic flows, or crystalline rock such as granite underlie the unconsolidated sedimentary formations of the Coastal Plain. These rocks do not represent the true "basement" but are herein referred to as such for convenience.

Recent studies of seismic activity in the Charleston area have greatly modified traditional beliefs concerning the nature of these rocks. It was previously thought that the consolidated rocks underlying the Coastal Plain sediments were buried extensions of metamorphic and intrusive rocks exposed in the Appalachian Piedmont Province. However, the Coastal Plain basement is much different and is more complex than previously supposed.

Much of the basement surface beneath Charleston, Berkeley, and Dorchester Counties is dominated by an extensive volcanic field and large mafic plutons mixed with or separated by units of consolidated clastic rock. Three deep test wells drilled in the area have encountered differing lithologies beneath the unconsolidated Coastal Plain sediments. The basement test well at Summerville is reported to have penetrated volcanic diabase at −2,430 ft msl; the Clubhouse Crossroads well pentrated 138 ft of basalt beginning at −2,430 ft msl and a deep well at Seabrook Island encountered fine-grained quartzitic sandstone at −2,670 ft msl.

The basalt encountered at Clubhouse Crossroads is similar to basalts from the Atlantic-type continental margins of eastern North America, Tasmania, Antarctica, and South Africa and have estimated ages of 94.8 to 109 million years. The basalts are of a type associated with tensional faulting, hence suggesting the existence of a buried Triassic basin beneath the Charleston area (see Gottfried and others, 1977).

The basement surface, shown in Figure 10, dips generally south-southeast at an average rate of about 40 ft per mile. It lies at approximately −1,500 ft msl in northernmost Berkeley and Dorchester Counties, dipping to −3,000 ft msl in southern Charleston County. A trough-like depression in the basement surface west of Charleston has been defined by Campbell (1977) and Ackerman (1977).

Features within the basement rocks are shown in Figure 11. The features include east-west and northwest trending faults through northern Berkeley and Dorchester Counties, large northwestern trending diabase dikes, and several large Triassic (?) plutons whose tops occur at about −4,900 ft msl or about 2,600 ft below the basement surface (see Popenoe and Zietz, 1977). Layers possibly representing deeper volcanic flows or the true crystalline basement have been identified at several depths below the basaltic basement surface (Ackerman, 1977; Campbell, 1977; Phillips, 1977).

Cretaceous Units

Middendorf Formation

The name "Middendorf" was applied by Sloan (1904) to presumed Lower Cretaceous exposures near the town of Middendorf, Chesterfield County, South Carolina. Berry (1914) assigned the unit to the Upper Cretaceous, and C.W. Cooke (1926) revised the terminology and correlations of earlier investigators and included the "Middendorf" and lower beds of Sloan (1907) and the "Middendorf" arkose member of Berry (1914) in the Middendorf Formation. Cooke (1936) later considered the Middendorf and "Hamberg" beds of Sloan to be similar to the Tuscaloosa Formation of Alabama, and he used the name "Tuscaloosa", as did Mansfield (1937). Dorf (1952) referred to the Formation in Chester County as the "Middendorf Member" of the Black Creek Formation and to the underlying rocks as "Lower Cretaceous (undifferentiated." Subsequently, Heron (1958b) and Swift and Heron (1969) returned to the term Middendorf Formation for its occurrence in the Cape Fear area of North Carolina. The USGS has recently used the term for Upper Cretaceous units within the boundaries of the present study area (Gohn and others, 1977; Hazel and others, 1977).

Gohn and others (1977) also described an underlying unit at Clubhouse Crossroads as the "Cape Fear Formation". Gohn and Hazel (1979) suggested that the Middendorf and Cape Fear Formations of Gohn and others (1977) and Hazel and others (1977) are not the same units as those so named in the outcrop areas. Therefore the Middendorf and Cape Fear Formations of Gohn and others (1977) and Hazel and others (1977) are grouped under the name "Middendorf" in this report for the sake of convenience.

The lower 200 ft of the Middendorf Formation (Cape Fear of Gohn and others, 1977) is composed of interbedded red, brown, yellow, or olive-gray clay and silty clay; and greenish-gray, muddy, locally feldspathic sand. The sand and clay contain varying amounts of mica, pyrite, and shell fragments. The upper part of the formation consists of a cyclical sequence of red to reddish-brown and gray-green, poorly sorted feldspathic sand, reddish or red and gray-green mottled clay, clayey silt, and silty clay. The sediments represent continental and marginal marine depositional environments (see Gohn and others, 1977).

The top of the formation occurs at about −1,000 ft msl at St. Stephen, −1,860 ft msl at Clubhouse Crossroads, and at −2,180 ft msl at Kiawah Island. The average dip of the surface of the formation is southwest at about 36 ft per mile. The formation is 600 ft thick at Clubhouse Crossroads and approximately 600 ft thick at Kiawah Island, with the thickness increasing toward the southeast.

Black Creek Formation

Ruffin (1843, p. 25) first noted the black shales in Darlington and Florence Counties that were later referred to as the "Black Creek Shales" by Sloan (1907, p. 12-14), and which Sloan (1908) described as the Black Creek Formation. The term Black Creek Formation has since been used to include the Snow Hill Marl Member (Stephenson, 1923; Cooke, 1926; Dorf, 1952; Heron, 1958a, 1958b) and all or part of the Middendorf Formation as a member. Swift and Heron (1969, p. 217) thought the Black Creek interfingered with the Middendorf (Tuscaloosa), a conclusion predominantly based on outcrop data. Woolen (1978) assembled both outcrop and subsurface data for northeastern South Carolina and suggested a similar contact.

The lithology and paleontology of the formation in the subsurface of the study area were described by Cooke (1936), Mansfield (1937), Gohn and others (1977), Hazel and others (1977), and Hattner and Wise (1980).

Gohn and others (1977, p. 67) describe the formation as abundantly fossiliferous silty clay, muddy sand, and clean sands alternating in 50- to 150-ft thick sequences with thinly interbedded sand and clay and some shelly limestone. The silty clay and muddy sand are gray to gray-green with minor quantities of glauconite, phosphate, mica, and pyrite. Locally, macrofossil shells and microfossil tests are abundant, and the calcium carbonate content is high. Feldspathic quartzitic silt and well-sorted fine sand occur near the base of the formation, and well-sorted calcareous quartz sand occurs in the upper part. The clay has as much as 20 percent black carbonaceous material. Black Creek sediments were deposited in environments ranging from marginal marine to middle shelf (Gohn and others, 1977; Hazel and others, 1977).

The top of the Black Creek Formation occurs at −530 ft msl at St. Stephen, −1,050 ft, at Clubhouse Crossroads, and −1,420 ft at Kiawah Island. The dip is toward the southeast at a rate of about 30 ft per mile. Thickness increases from about 500 ft in northern Berkeley County to 750 ft in southern Charleston County.

Peedee Formation

The Peedee Formation is named for beds cropping out along the Pee Dee River in Florence County. Ruffin (1843, p. 7) first described the "Peedee beds" that were later designated as the "Burches Ferry marl" at a type locality in Florence County by Sloan (1907, p. 12-14). Stephenson (1923) returned to the use of the term "Peedee," which has been retained in subsequent publications. The formation occurs only in the subsurface within the project area.

At Clubhouse Crossroads the formation is represented by calcareous muddy sand and calcareous mud. There, the lower part of the Peedee is predominantly composed of olive- to medium-gray, fossiliferous, muddy sand containing small amounts of glauconite, phosphate, and mica. The upper part is composed of olive- to medium-gray, silty and sandy calcareous caly. Calcium carbonate, in the form of fossils and cement, ranges from 10 to 40 percent; accessory minerals include glauconite, phosphate, pyrite, and mica (Gohn, and others, 1977, p. 68).

The Peedee underlies the entire study area. The top lies at about −200 ft msl in northern Berkeley County, dipping southwestwardly to −800 ft at Clubhouse Crossroads and −700 ft at Charleston. The average dip is about 25 ft per mile. Its thickness ranges from 320 to 450 ft, increasing at about 4 ft per mile toward the south.

Principal Tertiary Units

Black Mingo Formation

The name "Black Mingo" was originally applied to exposures of "shale" along Black Mingo Creek in adjacent Williamsburg and Georgetown Counties by Sloan (1907). He later (1908) used the term "Black Mingo phase" to include all rocks of lower Eocene age east of the Santee River. After mapping the outcrop and subcrop areas, Cooke (1936, p. 41) referred to all Eocene rocks older than the McBean Formation as the "Black Mingo formation". As used in this report, the name is applied to strata referred to as the "Black Mingo" and "Beaufort (?)" Formations by Gohn and others (1977) and Hazel and others (1977).

The Black Mingo is a heterogeneous, fossiliferous sequence of white to pale-gray limestone, green to gray argillaceous sand, carbonate and silica-cemented sandstone, and dark-gray to black clay. In the outcrop areas of northern Berkeley County, the formation chiefly consists of clay, shale, sand, and limestone; shale and clay being more abundant in the lower part, and sand and limestone being more prevalent in the upper part. The sand is white to pale gray in the absence of glauconite and pale green to dark green where glauconite is present (Taber, 1939, p. 4; Poozer, 1965, p. 11; Spiers, 1975, p. 15). Montmorillonite clay is common in the updip portion of the Black Mingo (Heron, 1969, p. 34; Heron and others, 1965) and is commonly dark gray with small quantities of pyrite. Lithological and paleontological data indicate that the updip portion of the Black Mingo was deposited in inner-shelf and marginal-marine environments (Poozer, 1965, p. 11). Downdip, the subsurface section at Clubhouse Crossroads reflects a broader range of depositional environments. The lower segment (Beaufort (?) of Gohn and others (1977)) is predominantly a yellow-gray to greenish-gray, somewhat calcareous or sandy clay including glauconite, carbonized wood, and pyrite, generally deposited in an inner- or middle-shelf environment. The overlying segment is similar, consisting of gray-green silty clay and muddy sand, interbedded sand and clay, and quartzose shelly limestone. Illite is the most common clay mineral. Gohn and others (1977) suggested that these sediments are the result of inner-shelf and marginal marine environments.

Black Mingo sediments generally are a mixture of detrital material and volcanic ash (Heron, 1969, p. 28). The silicate minerals, opal and clinoptilolite, are common in the updip regions of the formation (Heron, 1969, p. 37), and cristobalite is reported to be abundant in much of the formation in the Clubhouse Crossroads corehole (Gohn and others, 1977, p. 63).

The formation crops out north of Moncks Corner in Berkeley County and throughout much of adjacent Georgetown and Williamsburg Counties. Its surface dips south-southwest beneath the Santee Limestone at a rate of 17 ft per mile, lying at sea level in the vicinity of Bonneau in Berkeley County and dipping to more than −600 ft msl in southern Charleston County (Fig. 12). The formation thickens from approximately 300 ft at Moncks Corner to 400 ft at Seabrook Island.

Santee Limestone

Early geologists grouped the undifferentiated Santee Limestone and Cooper Formation with the Upper Cretaceous, until Lyell classed them with the Eocene. Tuomey (1848, p. 154-169) and Clark (1891, p. 52-54) differentiated between the Eocene "Santee beds" and the overlying Cooper Formation, and Sloan (1908, p. 462-463) later applied the names "Santee marl" and "Mt. Hope marl" to the limestone. In 1936, Cooke (p. 75) gave the name "Santee Limestone" to limestone he then considered as part of the Eocene Jackson Group but which he and F.S. MacNeil (1952, p. 24) later identified with Claiborne units. The Santee Limestone is a creamy-white to gray, fossiliferous and slightly glauconitic calcilutite to calcirudite. In the outcrop areas it usually contains more than 80 percent calcium carbonate, and locally it contains 90 to 96 percent calcium carbonate (see Heron, 1962). The base of the limestone becomes increasingly glauconitic and arenaceous at the north edge of the outcrop, where it intertongues with underlying limestone of the Wharley Hill Formation (Poozer, 1965, p. 16-17). Downdip, the calcium carbonate content decreases to between 40 and 80 percent, and quartz sand, glauconite, and phosphate percentages increase (Gohn and others, 1977, p. 68-69). The distribution of carbonates and sediments is shown in Figure 13.

Two members have been recognized within the Santee Limestone, the lower unit being referred to as the Moultrie Member and the upper unit as the Cross Member. The Moultrie Member is characterized by biosparites in the form of mold and cast limestone and bryozoan hashes of a Middle Claibornian age. The Cross Member unconformably overlies the Moultrie and consists of a brachiopod-bivalve biomicrite of late Clairbornian age (Ward and others, 1979). The upper surface of each member tends to be rich in phosphate and can be identified by a marked departure from the zero baseline on natural gamma-ray logs (Fig. 14).

The Santee Limestone lies on the southern flank of the Cape Fear Arch, from which it has been partially eroded. It extends south and west of the arch and underlies all of the study area except the northernmost corner of Berkeley County. It occurs at shallow depths in a belt extending westward from northeastern Charleston County into southern Orangeburg County (Fig. 5). The limestone is overlain by a thin veneer of Miocene to Pleistocene sand and clay in the subcrop area and by the Cooper Formation south of parallel 32° 11 ′00″. The surface of the Santee dips southward at an average rate of 8.3 ft per mile between Moncks Corner and Edisto Beach. The dip averages 6 ft per mile in the outcrop area, and locally is as much as 17 ft per mile in the subsurface (Fig. 15). Its thickness increases southward at an average rate of 5 ft per mile and ranges from a few feet at the north edge of the limestone to more than 300 ft at Edisto Beach (Fig. 16).

Cooper Formation

The Cooper Formation is the most extensively studied rock unit in the Trident Area; its earliest observers included Vanuxem (1826), Morton (1834), and Lyell (1845). Toumey (1845) differentiated between the Cooper Formation and the underlying Santee Limestone. Between 1867 and 1920, when the Charleston area was a major source of agricultural lime and phosphate, the Cooper Formation received further attention from Holmes (1870), Moses (1872), Rogers (1914), and numerous others (Malde, 1959, p. 4). Many additional reports, addressing the Cooper in part or in whole, have resulted from recent USGS investigations into the Charleston earthquake of 1886. These include Gohn and others (1977), Hazel and others (1977), Higgins and others (1978), and Ward and others (1979).

The names applied to the formation have been varied. Ruffin (1843, p. 7), in describing the "Great Carolina beds" (present Cooper Formation and Santee Limestone), referred to "Marl of the Ashley and Cooper Rivers . . . ". His predecessors used a great number of other terms: "Cooper River Beds" (Holmes, 1870), "Cooper River Marls" (Dall 1898), "Ashley Marl" and "Cooper Marl" (Sloan, 1908), and others. Reports between Stephenson (1914) and Hazel (1976) generally referred the formation as the "Cooper Marl". Malde (1959, p. 10) and Poozer (1965, p. 20) noted that the formation was not a true marl because of its small clay component and large sand component, and the USGS has since accepted the name "Cooper Formation" (Hazel, 1976, p. 54; *in* Cohee, 1976).

Early nineteenth century geologists assigned the Cooper Formation and underlying limestones to the Upper Cretaceous until Charles Lyell (1845, p. 434) pronounced the formations Eocene. Toumey (1884), Holmes (1870, p. 13), and Cooke (1936, p. 72) also classed the Cooper with the Eocene, but Dall (1898), Cooke and McNeil (1952, p. 27), Malde (1959, p. 25), and Poozer (1965, p. 22) referred it to the Oligocene. Hazel and others (1977, p. 74-75) give evidence that the Cooper contains both Eocene and Oligocene beds.

Lithologically, the Cooper Formation is a sandy, phosphatic limestone that is uniform in color and texture and has no obvious signs of bedding. Malde (1959, p. 9), referring mainly to surface exposures, describes the formation as "carbonates (25-75 percent), sand (10-45 percent), clay (2-3 percent), and phosphate (5-20 percent). A description of a core taken near Summerville is similar: calcium carbonate (60-75 percent), quartz sand (5-25 percent), clay (10-30 percent), phosphatic sand and pebble (1-5 percent), and small amounts of glauconite, bone, shell hash, and mica (Gohn and others, 1977, p. 69). The carbonate component consists principally of foraminiferal shell (Malde, 1959, p. 9, 12; Gohn and others, 1977, p. 69). Color ranges from pale-green or yellowish gray to olive brown, becoming lighter when dried.

The Cooper has been divided into three members, which are, in ascending order; Harleyville Member (Eocene), Parkers Ferry member (Eocene), and Ashley member (Oligocene) (Ward and others, 1979, p. 14-26). The Harleyville varies from a phosphatic, calcareous clay and clayey calcarenite at the type exposure to a clayey, very fine-grained limestone in the subsurface. It thins out northward toward the Santee River and thickens toward Charleston, filling a local basin. The overlying Parkers Ferry Member is a glauconitic, clayey, fine-grained limestone with abundant microfossils and mollusk and bryozoan fragments; the unit occurs only in the subsurface and is absent in northern Berkeley and Dorchester Counties. Phosphatic, muddy, calcareous sand comprises the Ashley Member, which unconformably overlies the Parkers Ferry Member and, locally, the Harleyville Member (Ward and others, 1979, p. 14-26).

The Cooper Formation underlies most of the area south of the Santee River and occurs near land surface in a 12- to 20-mile wide east-west trending belt through upper Charleston, Berkeley, and Dorchester Counties. It thickens southward from a few feet in the vicinity of Moncks Corner to more than 300 ft at Edisto Island (Fig. 17). Its surface dips south-southeast at 8 ft per mile, occurring at about 80 ft msl in northern Dorchester County and 40 ft msl in southern Charleston County (Fig. 18; also see Malde, 1959, plate 2; Colquhoun, 1961).

Locally, the surface of the Cooper exhibits a relief of 15 to 20 ft. The greatest relief occurs within an erosional basin in the vicinity of Charleston and is on the order of 40 to 50 ft. Higgins and others (1978, Fig. 1) depict a similarly oriented basin in the underlying Eocene surface of the Cooper. Intraformational units also contain some signs of faulting that are not readily apparent at the surface of the Cooper, according to Colquhoun and Comer (1973). However, the apparent discontinuities observed in their seismic data could instead be related to erosion.

Shallow Tertiary and Quaternary Units

Edisto Formation

Ward and others (1979, p. 26) have applied the name "Edisto Formation" to the pale-yellow, sandy, fossiliferous limestone that overlies the Cooper Formation in western Dorchester County. They designated the left bank of the Edisto River, 0.3 mile above S.C. Highway 61 near Givhans as the lectostratotype. Sloan (1908) originally applied the name "Edisto Marl"; Cooke (1936, p. 86) grouped it with the Eocene Cooper Formation in the vicinity of Givhans; and Malde (1959, p. 26) separated it from the Cooper, referring to the formation under the heading of "Lower Miocene (?) Deposits". The Edisto Formation occurs as an erosional remnant southwest of the type location and pinches out to the northeast. In the vicinity of the Ashley River, Sloan's "Edisto Marl" is grouped with the Hawthorn Formation by Cooke (1936, p. 113-115); Ward and others restricted the unit to the area northwest of U.S. Highway 17 at the Edisto River.

Hawthorn Formation

The Hawthorn Formation was named from the town of Hawthorne, Alachua County, Florida (Dall and Harris, 1892, p. 107). C.W. Cooke (1936, Fig. 2) mapped the Hawthorn into South Carolina as far north as Charleston, including parts of Sloan's (1908) "Ashley" and "Edisto Marls" and generally describing the formation as a middle Miocene "fine sandy, phosphatic limestone". Johnson and Geyer (1965, p. 4) reported that the Hawthorn occurs as a feather edge along the Edisto River, dipping south-southwest and attaining a thickness of about 120 ft. The Hawthorn appears to have been removed by erosion in the Charleston area but may occur locally as thin remnants of sand and clay (Malde, 1959, p. 28).

Pleistocene Formations

Pleistocene deposits within the limits of the study area provisionally are represented by the "Wicomico", "Penholoway", "Talbot", and Pamlico" Formations (see Cooke, 1936, p. 130-154). The names were adopted from work by Shattuck (1906), Stephenson (1912), Cooke (1925), and others. Cooke described the formations as resulting from a glacially controlled Pleistocene sea whose retreat was periodically interrupted by rises of sea level. The result was a topographic succession of terraces and abrupt shorelines cut during interglacial stands of sea level. The local occurrence of each formation was therefore determined on the basis of topographic elevation, as well as by lithology. Thus the Wicomico lies between +100 ft and +70 ft msl; the Penholoway lies between +70 ft and +42 ft msl; the Talbot lies between +42 ft and +25 ft msl; and the Pamlico lies between +25 ft and 0 ft msl. Differing and more detailed interpretations of the geomorphology and lithology of these units have been published by Flint (1940), Richards (1943, 1959), Doering (1958, 1960), Maulde (1959), Colquhoun (1961, 1962, 1969), and others.

The Wicomico generally is composed of fine sand, but it contains some clay, coarse sand, and gravel locally. Estuarine deposits are coarser and contain more gravel than sediments deposited in the open sea. The thickness averages less than 25 ft and rarely exceeds 50 ft (Cooke, 1936, p. 143). As the result of leaching, carbonate clastics are scarce (Colquhoun, 1961, p. 48).

Cooke (1936, p. 147-148) defined the Penholoway as deposits laid down when the sea was about 70 ft above present mean sea level. He gave three locations in Dor-

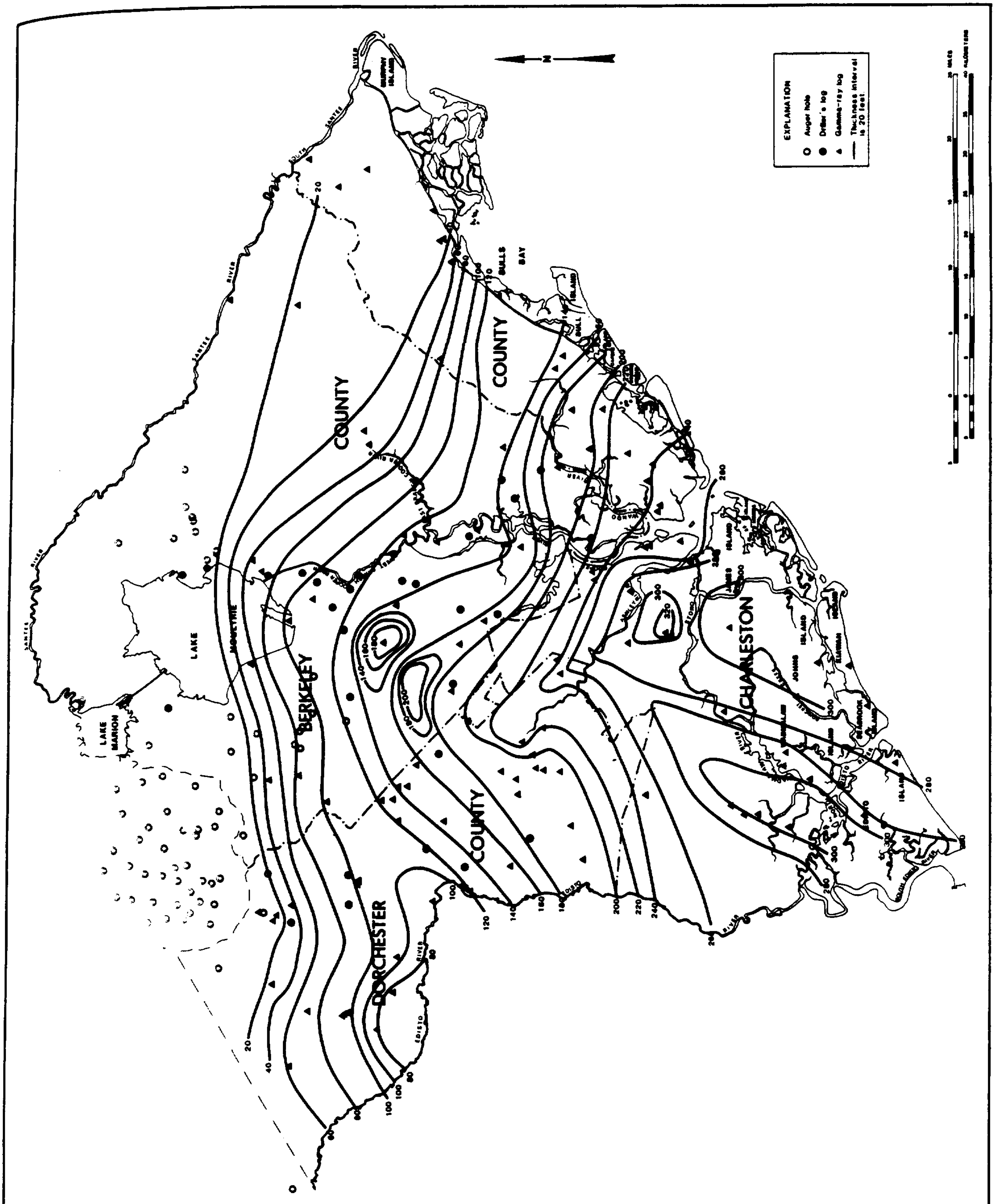

Figure 17. Thickness contours for the Cooper Formation.

chester County and described a section at Four Hole Swamp as 4½ ft of "dark grey pebbly sand . . . passing upward into fine black carbonoecous sand" overlain by 15 ft of "Fine white crossbedded sand weathering yellow (beach or river deposit)". Locally, coarse basal sands in the Penholoway appear similar to those underlying the Wicomico (Colquhoun, 1962, p. 72). Penholoway sediments are reported to overlap those of the Talbot in the vicinity of Summerville (Malde, 1959, p. 36).

The Talbot Formation generally consists of very fine gray to red or pink thin-bedded sand and clay. Malde (1959, p. 36) includes it as a unit within his "Ladson Formation". According to Cooke (1936, p. 149), the Talbot may have been formed in bays and drowned river valleys. The landward limit of the Talbot is represented by an abandoned shoreline lying at +42 ft msl.

As described within the confines of the study area, the Pamlico Formation occurs at and below the 25-ft topographic contour. Adapting a section described by Sloan (1908) at Johns Island in Charleston County, Cooke (1936, p. 151) listed a section containing 5 ft of green glauconite clay-sand, underlain by 3 feet of sand, in turn underlain by 2 ft of Pleistocene shell. Pugh (1905) reported 179 species of shells collected from the formation in the vicinity of Charleston. The thickest sequence of Pamlico deposits occurs in the coastal section of Charleston County where 40 to 60 ft of sand, clay, and shell overlie the Cooper Formation.

HYDROGEOLOGY

General Principles of Ground-Water Occurrence

The occurrence, movement, availability, and chemical quality of ground water in Charleston, Berkeley, and Dorchester Counties are intimately related to the geology. Ground water is obtained from aquifers, geologic formations that are capable of yielding water to wells or springs. Aquifers in the study area consist of sand and limestone. Confining beds overlie or underlie aquifers and are strata that cannot yield appreciable amounts of water to wells or springs. The confining beds identified in the study area are composed of sandy limestone and clay.

Ground water in an aquifer may occur under artesian (confined) or water-table (unconfined) conditions. The water level in a tightly cased well penetrating the first few feet of a water-table aquifer defines the water table, on which the pressure is atmospheric only.

Artesian aquifers are contained by confining beds. Ground water in artesian aquifers is under pressure, as in a pipe, and the water level in a well completed in an artesian aquifer will rise above the top of the aquifer. The water level in such a well represents a point on the potentiometric surface, an imaginary surface to which water will rise in tightly cased wells completed in the same aquifer. The slope of the potentiometric surface determines the direction of flow of water in an artesian aquifer.

Ground water flows from areas of recharge to areas of discharge. The rate of ground-water movement is dependent upon the hydraulic gradient and the hydraulic conductivity. Hydraulic gradient is the change in hydrostatic head per unit of distance and is usually expressed in feet per mile. Hydraulic gradients are determined from the slope of the potentiometric surface.

The quantity of water that can be pumped or will flow from a properly constructed well is dependent upon certain properties of the aquifer being tapped. These properties include the hydraulic conductivity, transmissivity, and storage coefficient. Aquifer properties can be determined by means of aquifer tests and the use of specific formulas and graphical computations. When these methods are combined with adequate geologic knowledge of an area, useful projections of ground-water availability can be made.

Hydraulic conductivity (K) is the ability of an aquifer to transmit water. It is the rate of flow, in feet per day or meters per day, through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot at the prevailing water viscosity.

Transmissivity (T) is the rate of flow of water, at the prevailing water temperature, through a vertical strip of the aquifer 1 foot wide and extending the full saturated height of the aquifer under a hydraulic gradient of 1 foot per foot. Transmissivity is K multiplied by aquifer thickness (m) and is expressed in ft^2/day or m^2/day (reduced forms of ft^3/day/ft and m^3/day/m).

Storage coefficient (S) is related to the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. The storage coefficient is a dimensionless term, and typical values range between 0.3 and 0.03 for water-table aquifers and between 0.005 and 0.0005 for artesian aquifers. Values from 0.03 to 0.005 indicate conditions that are neither truly water-table nor artesian (American Water Works Association, 1973.)

A characteristic of wells commonly utilized by well drillers, hydrologists, and engineers, and which is related to K, T, and S, is specific capacity. The specific capacity of a well is the rate of discharge divided by the drawdown in water level after a specified period of time (commonly 24 hours) and is expressed as gallons per minute per foot. Specific capacity can be used to compare the performance of wells and to estimate transmissivity, but not storage coefficient.

Middendorf Formation

The Middendorf Formation occurs throughout the study area and is the most extensive water-bearing formation in the South Carolina Coastal Plain. It underlies nearly all of the Coastal Plain Province between North Carolina and Alabama. In the areas north and west of Charleston, Berkeley, and Dorchester Counties, it is greatly relied upon where large quantities of water are required for public supply, industry, and irrigation.

Few wells in the study area obtain water only from the Middendorf Formation. The aquifers in the overlying formations are less expensive to develop and, in most areas, contain water of equal or better chemical quality. Wells screened in the formation usually are screened in the overlying Black Creek Formation also. Only two test wells, 19Y-w3 and 18AA-e2, and four production wells, 18W-a1, 18W-a5, 18W-b1, and 18AA-e4, are screened solely in the Middendorf Formation.

Well 18AA-e4, located north of Goose Creek, was constructed with 88 ft of screen set between −1,510 and −1,640 ft msl, in the upper 200 ft of the formation, and is by far the most productive well in the study area. During initial testing it yielded more than 2,000 gpm, and non-pumping flow was greater than 900 gpm. A pumping test conducted by maintaining non-pumping flow at 800 gpm indicated a specific capacity of 17 gpm/ft. Middendorf aquifer wells 18W-a1 and 18W-a5, at St. Stephen, yield 300 to 500 gpm with specific capacities on the order of 8 gpm/ft.

Only limited hydraulic data are available from pumping tests in Charleston, Berkeley, and Dorchester Counties. However, it is apparent that the transmissivity and hydraulic conductivity of Middendorf aquifers are far lower in the study area than in areas to the west. Siple (1975, p. 35) estimated transmissivities as great as 21,000 ft^2/day in central Orangeburg County. The average transmissivity calculated for several sites in Sumter and Richland Counties was about 6,000 ft^2/day (Park, 1980, Table 3). The highest transmissivities observed are at the Savannah River Plant in Aiken and Barnwell Counties, where an average value calculated for 25 pumping tests was 20,000 ft^2/day (Siple, 1967b, p. 31-35). These high transmissivities occur in areas where the Middendorf Formation contains coarse-grained deltaic deposits that are generally absent in the study area.

The transmissivity of sand beds in the upper 100 to 150 ft of the formation may lessen toward the southeast where drill samples and geophysical logs generally indicate thinner, finer-grained sand beds that were deposited in delta-fringe and marginal-marine environments.

Medium- to coarse-grained sand beds are reported in the lower section of the formation near St. George (25Z-b1), Clubhouse Crossroads (23CC-i1), and Seabrook Island (20GG-e1). However, core and drilling-sample descriptions indicate small amounts of silt and clay that may significantly reduce permeability. Test well 18AA-e2 produced only 1½ gpm with 43 ft of drawdown during a "packer" test on the lower section.

Although transmissivities in the study area may locally be greater than those estimated for the Goose Creek area, they probably do not approach the transmissivities that exist in the Upper Coastal Plain and Middle Coastal Plain Provinces of South Carolina.

Throughout the study area, static water levels in the Middendorf Formation are above land surface. The static level at well 18AA-e2 is about +120 ft msl, and in well 20GG-e1, at Seabrook Island, the static level is +140 msl (Walter Aucott, USGS, written communication). Ground water in the Cretaceous aquifers has generally been assumed to flow toward the south or southeast. However, the static levels in wells penetrating the Middendorf Formation at Hilton Head Island and Parris Island, 50 to 60 miles to the southwest, are 10 to 40 ft higher than the levels measured near Moncks Corner, Goose Creek, and Seabrook Island. Thus it appears that the potentiometric surface slopes toward the east, or possibly the east-northeast.

Black Creek Formation

The Black Creek Formation generally is not as productive as the underlying Middendorf Formation and is largely undeveloped. Eleven wells are open only to the Black Creek Formation and another 10 wells are screened in both the Black Creek and Middendorf. Thirteen of these wells are incorporated in public water-supply systems that typically blend Black Creek and Middendorf aquifer water with that of shallow wells or with surface water.

The Black Creek wells in operation in 1983 were located at Hampton Plantation, in northern Charleston County, and in the vicinities of Jamestown, St. Stephen, and Mt. Pleasant. The well at Hampton Plantation (12Y-L1) and the two wells at Jamestown (15X-L1 and 15X-L5) have 40 to 60 ft of screen set opposite sand in the upper 200 ft of the Black Creek Formation. These wells produce 125 to 275 gpm and have specific capacities of 0.8 to 2.3 gpm/ft.

Two Mt. Pleasant Water Works and Sewer Commission wells (16CC-y1 and 17DD-m5) are screened in the lower 200 ft of the Black Creek Formation and, within the study area, are the highest yielding wells in the formation. Both wells have been tested at discharges greater than 700 gpm, with specific capacities of 2.5 gpm/ft for 16CC-y1 and 4.8 gpm/ft for 17DD-m5. Well 19CC-x1, northwest of Charleston, was screened in corresponding sand beds, but it produces only 240 gpm with a specific capacity of 0.8 gpm/ft.

Wells screened in both Black Creek and Middendorf aquifers are, on the whole, better producers than are those screened only in the Black Creek Formation. In the St. Stephen area, industrial and public-supply wells that have 50 to 60 ft of screen set between 1,060 and 1,260 ft are pumped at 270 to 400 gpm. Specific capacities range from 6 to 10 gpm/ft. The two wells operated by the Town of Summerville have approximately 65 ft of screen set between 1,600 and 1,700 ft and yield about 500 gpm with a specific capacity of 4 gpm/ft. One of these, well 21BB-m3, was tested at 900 gpm.

Comparable wells in the Mt. Pleasant area have been between 80 and 100 ft of 8-inch diameter screen set in the interval of 1,800 to 1,975 ft. These wells produce 400 to 1,000 gpm and have specific capacities of 4.1 to 7.8 gpm/ft.

Transmissivity and hydraulic-conductivity estimates were made for four sites in the study area on the basis of aquifer tests at Jamestown (well 15X-L1) and Mt. Pleasant (wells 17DD-g1, 17DD-m5, 16CC-y1). In each test, water-level measurements were made only in the pumping well; no observation wells were used. The wells were shut down for at least 24 hours prior to the beginning of their tests, and drawdown and recovery measurements were made over a 48-hour period. Transmissivity calculations were based on the recovery data, which are illustrated for well 16CC-y1 in Figure 19. The values for hydraulic conductivity were obtained by dividing the transmissivity by the length of screen in the pumped well. Tests of this nature do not account for the effects of partial screen penetration, multiple screen locations, or well inefficiency; nor do they permit calculation of the storage values.

The data from the test at Jamestown indicate a transmissivity of about 930 ft^2/day and an average hydraulic conductivity of 19 ft/day. This well is mainly screened in the upper half of the Black Creek system, and it is possible that more permeable sand exists at greater depths in the Jamestown area.

The transmissivities calculated for the Mt. Pleasant area were only slightly greater than that for Jamestown. They range from approximately 1,200 ft^2/day, at wells 16CC-y1 and 17DD-m5, to about 2,600 ft^2/day at 17DD-g7, which is screened in both Black Creek and Middendorf aquifers. Hydraulic conductivities range from 21 to 32 ft/day.

Zack (1977, p. 31) reported the values of transmissivity and hydraulic conductivity for the Black Creek System at 14 well sites in Horry and Georgetown Counties. His calculations indicated that transmissivities there range from 390 to 5,350 ft^2/day and that hydraulic conductivities range between 2 and 59 ft/day. He reported storage coefficients that range from 0.0001 to 0.0004.

The transmissivity and hydraulic conductivity values measured in the study fall well within the range of values reported for Horry and Georgetown Counties, although they are somewhat below the averages of 1,733 ft^2/day and 30 ft/day reported by Zack (1977). Nonetheless, a comparison of pumping-test data for Black Creek wells in the study area, Horry County, and Georgetown County indicate similar hydraulic characteristics.

Water levels in the Black Creek Aquifer System are generally higher than +80 ft msl, except in the vicinity of the major pumping centers and in the northeastern section of the study area. Ground water in the system evidently moves toward the east, since static levels of about +160 ft msl are reported at Walterboro, in Colleton County; Zack (1977) reported levels of +20 to zero feet msl in Georgetown County.

A noticeable cone of depression exists in the vicinity of Mt. Pleasant, where six public supply wells withdraw about 1.5 mgd from the Black Creek and Middendorf aquifers. The static level at well 17DD-a4, near the center of the cone of depression, has declined from approximately +90 ft msl in 1973 to +53 ft msl in 1983. The decline should be a matter of concern, since relatively high chloride concentrations have been observed in Black Creek aquifers near Charleston. The chlorides suggest the existence of saltwater-bearing zones to the east, from which saltwater could intrude as pumping increases and water levels decline further.

Peedee Formation

Scant information is available for the Peedee Formation. The earliest known Peedee well was drilled for the City of Charleston in 1823 and penetrated to a depth of 1,250 ft. Two wells of similar depth and construction were drilled in 1849 and 1896; both of which were disappointments in the quantity and the quality of ground water produced. Since that time, no Peedee wells have been drilled in the Charleston area.

Less than 10 Peedee wells are known to have been drilled in the remainder of the study area. Of these, only one, which belongs to the Town of Moncks Corner, is fully cased and screened. That well has a total depth of 807 ft and has 8-inch diameter screen set between 633 and 693 ft. When drilled, the well had a static water level above land surface (55 ft msl) and produced 200 gpm with 240 ft of drawdown for a specific capacity of 0.8 gpm/ft.

For central Orangeburg County, Siple (1975, p. 36) and the writer have observed coarse-grained, well-sorted Peedee sand that suggests highly permeable zones, at least locally. However, the facts that the Peedee is largely ignored as a source of water supply in the study area and that the few wells tapping it have very modest yields attest to the generally low transmissivity of the formation. This characteristic is not unique to the present study area. Siple (1945, 1957) reports that the permeability of Peedee sand is quite low in most areas of the Coastal Plain and that water levels in the system are substantially affected in areas of heavy pumping.

Water levels in the Peedee are above land surface throughout most of the study area, but the direction of ground-water movement is not known. USGS records report water levels higher than +25 ft msl at Charleston and Sullivans Island; well 18DD-k1 at Charleston had a static head of 29.5 psi (70 ft msl) in April, 1983; and well 19Y-s1 had a static level greater than 55 ft msl when completed in September, 1975.

Santee Limestone and Black Mingo Formation

The Santee Limestone in Charleston, Berkeley, and Dorchester Counties is the northernmost segment of one of the most extensive limestone aquifers in the United States. It is part of a series of limestone formations that extend southward from the Santee River into eastern and southeastern Georgia, Florida, and adjacent parts of Alabama. Formations within the system occur near land surface in a southeast-trending belt between Tallahassee and Tampa, Florida, and in a northeast-trending belt that parallels the fall line from Alabama to southeastern South Carolina. The system dips coastward and away from the Cape Fear Arch of North Carolina and the Peninsula Arch and Ocala uplift of Florida, thickening from a few feet in the outcrop areas to more than 12,000 ft in parts of Florida.

The limestone is an important source of fresh ground water in many parts of the Trident Area. As defined for the purposes of this report, it includes the lower Eocene "Fishburne Formation" of Gohn and others (1981), the middle Eocene Santee Limestone, and, locally, the uppermost limestone of the Paleocene Black Mingo Formation. Its lower boundary is everywhere marked by sand or clay of the Black Mingo, and, except in the northern portion of the study area, it is overlain by the Eocene and Oligocene Cooper Formation. The Cooper Formation is an effective confining unit, resulting in artesian conditions throughout most parts of the Santee Limestone.

The Black Mingo Formation underlies all of the study area, thinning out toward the north where it crops out in Sumter, Clarendon, Williamsburg, and Georgetown Counties, and thickening toward the south. Rocks of equivalent age extend into Georgia where they are generally undifferentiated in eastern Georgia and are assigned to the Tuscahoma, Nanafalia, and Clayton Formations in western Georgia. Ground water in the Black Mingo Formation occurs under artesian conditions except in the outcrop areas where water-table conditions may exist in the upper few feet of the aquifer.

Well Construction

Most wells tapping the Santee Limestone and the Black Mingo Formation are of open-hole construction. Because the limestones are poorly productive in many areas, wells typically penetrate the entire thickness of the limestone as well as sand beds in the upper 20 to 100 ft of the Black Mingo Formation. During development, large amounts of sand are pumped from the well, leaving a small cavity at the base of the well bore. This practice is generally satisfactory if the sand is overlain by limestone or hard clay, if large quantities of water are not required, and if the well does not penetrate the Black Mingo too deeply. A number of wells having as much as 500 ft of hole open to the Black Mingo and Peedee Formation are reported to have operated successfully in the past, but have since collapsed or been plugged by debris.

The local practice of constructing open-hole wells in unconsolidated rock carries the risk of partial well collapse. However, the chance of well failure is small if only a few feet of unconsolidated material is penetrated, and the risk is largely offset by the savings in casing and screen costs. The greater concern lies with the risk of interconnecting freshwater-bearing and saltwater-bearing aquifers and is discussed later in the section on water quality.

Domestic open-hole wells are typically 4 inches in diameter and are pumped by ½- to 1-horsepower submersible or jet pumps.

Irrigation and industrial wells are commonly 6 to 10 inches in diameter and are equipped with submersible or conventional turbine pumps of up to 40 horsepower.

Where the Cooper Formation is present, casing is set 20 to 100 ft into the formation; elsewhere the casing is usually seated a few feet below the top of the limestone or in Black Mingo clay. Both steel and polyvinyl chloride (PVC) casing are used, but PVC is the better choice for coastal areas where the ground water is brackish and corrosive.

Industrial and public supply wells have 20 to 100 ft of cement grout and usually have sanitary seals at the well head. However, domestic wells commonly are not grouted, and sanitary seals are often inadequate or nonexistent.

Wells completed only in the Black Mingo sand beds are usually screened. Because the sand is typically fine grained, a screen slot size of 0.015 inch or less is used locally, unless the well is to be constructed with a gravel filter. The gravel filter helps control the entrance of fine sand into the well and allows the use of larger screen openings. Slot sizes reported for gravel-filter wells range between 0.020 and 0.040 inch.

Water Bearing Zones and Well Yields

The permeable zones in the Santee Limestone consist of permeable limestone confined by layers of lower permeability limestone. Where the confining beds extend over a large area, the permeable zones are isolated from one another and have different hydraulic characteristics.

The conditions of ground-water occurrence and movement in these zones are not entirely analogous to those in sand-and-gravel aquifers. In the limestone, the ground water available to wells occurs in fractures and openings along bedding planes. As water moves through the fracture system, the limestone is dissolved, the fractures are enlarged, and the permeability increases. However, the permeability development is not uniform with depth or locality, for it is strongly controlled by factors such as the proximity to recharge areas, the chemistry of the ground water, and local variations in lithology and geologic structure.

Both the degree of permeability development and the position of water-bearing zones relative to the thickness of the aquifer vary from one part of the study area to another. Water-bearing limestone is believed to occur within the upper 50 ft of the system nearly everywhere except in central Berkeley and Dorchester Counties. This permeability is particularly marked in the outcrop/subcrop area of Berkeley and Charleston Counties where the very pure limestone has been weathered by circulating meteoric ground water. The permeability of the upper zones generally decreases in areas south of the outcrop area where the limestone is overlain by the Cooper Formation. Water-bearing zones also occur within the lower 50 to 150 ft of the aquifer system in southern Charleston and Dorchester Counties and are most productive in western Dorchester County and southernmost Charleston County. By contrast, permeability development is negligible in a large area surrounding Summerville and Goose Creek, where a combination of faulting (?) and relatively impure limestone may have hampered ground-water flow and the dissolution of the aquifer material.

The permeability of the Santee Limestone is low in comparison with the underlying Black Mingo Formation and with limestones in the counties to the south of the study area. Consequently, well yields are modest and, typically, will not exceed 300 gpm without causing more than 100 ft of drawdown in the well. However, yields are usually sufficient to supply domestic and light industrial needs. Wells in the outcrop areas east of Moncks Corner are between 30 and 100 ft in depth, and yields of up to 300 gpm are reported locally. Similar yields can be obtained from individual 200- to 450-ft wells in central and southern Charleston County and adjacent parts of Berkeley and Dorchester Counties. Permeabilities appear to be lowest in the central part of the study area, between Goose Creek and Summerville, where domestic wells have specific capacities of less than 2 gpm/ft and "dry holes" are reported locally.

of the study and is partially due to the very low permeability that occurs in this part of the study area.

Water level declines have also occurred in the vicinity of a limestone quarry located 2 miles east of Jamestown in Berkeley County. During 1978 the quarry withdrew as much as 36 mgd from the Santee Limestone to permit dry mining for road aggregate and agricultural lime. Until the operation reduced its pumping, water levels in the quarry frequently fell below sea level, spring-fed Dutart Creek dried up, and nearby property owners experienced problems with well-water supplies and sinkholes. The sinkholes ranged up to 25 ft in diameter and formed as a result of frequent water-level flucuations in the quarry and loading or vibrations caused by rainfall and the passage of heavy equipment. Although there were no personal injuries resulting from sinkhole collapses, collapses did occur on rights of way, adjacent to houses, and in cultivated fields near the quarry.

Cooper Formation

The Cooper Formation is significant as a hydrologic unit mainly by virtue of its impermeability. In most localities, its sandy, finely granular limestones produce little or no water, but instead act as confining material that causes artesian conditions in the underlying Santee Limestone. Only a few feet of the formation need to be present to effectively retard the vertical movement of ground water. The Charleston Public Works Department has taken advantage of this impermeability by boring a 5-foot diameter, 23-mile-long unlined tunnel through the Cooper Formation from the Edisto River at Givhans to their treatment plant at Hanahan.

Locally, permeable zones exist within the Cooper. A number of drilling logs report penetrating thin, soft, water-bearing limestone beds at depths of −200 to −250 ft msl in the vicinity of Edisto Island; whether they contribute significant amounts of water is not known.

A more noteworthy water-bearing zone occurs in the vicinity of Ravenel in southern Charleston County. There, a porous bryozoan limestone occurs between approximately −50 ft and −90 ft msl and is reported to yield as much as 300 gpm to some wells. The limestone is easily distinguished in gamma-ray logs as a zone of very low gamma-ray intensity sandwiched between the high gamma-ray intensity of limestone of the Ashley and Parkers Ferry Members. Although the unit is 30 to 40 ft thick at Ravenel, it pinches out only a few miles east, south, and west of the town limit, and apparently it extends no more than 10 or 12 miles to the north. Because the unit is limited to a small area and is overlain by a 30- to 40-ft confining unit that inhibits recharge, it may not be a reliable source of ground water for users such as public supply systems or industries.

Shallow Aquifers

The shallow aquifers encompass all rocks younger than the Cooper Formation; they include the Hawthorn Formation, Edisto Formation, and Pleistocene terrace deposits. South of latitude 33°12′00″, they directly overlie the Cooper, and elsewhere they overlie the Black Mingo Formation or Santee Limestone. In most areas, the shallow aquifers consist of discontinuous layers of sand, clay, and locally occurring beds of shell and limestone. The thickest sequence occurs in Charleston County where the base of the shallow aquifers lies 40 to 65 ft below land surface. Elsewhere, their thickness is generally less than 30 ft.

For most parts of the study area, ground water in the shallow aquifers occurs under water-table conditions. Although the shallow system locally may receive some recharge from the underlying Santee Limestone, most recharge is supplied by local rainfall. The water moves by gravity from areas of high elevation to areas of low elevation at a rate that depends on the slope of the water table and the permeability of the aquifer. Reported water levels are commonly 3 to 15 ft below land surface and, in part, reflect variations in the local topography. In general, water levels lie at greatest depth in areas of high elevation and are near land surface where elevations are low. Swampy areas result where the water table is at or very near the land surface much of the time.

The water table rises and falls in response to fluctuations in rainfall, seasonal variations in the rate of evapotranspiration, the topography, and the hydraulic characteristics of the aquifer. Typical water level changes in the area are on the order of 1 to 6 ft within a year. Figure 27 shows the fluctuations in water level in a shallow well, unaffected by pumping, at Edisto Island from May 1981 to January 1983. The minimum water levels occurred during November and December and coincided with a period of slight rainfall; during the following months the level recovered nearly 3 ft in response to increasing amounts of precipitation during a period of low rates of evapotranspiration.

Discharge from the shallow aquifers occurs as a result of pumping for domestic, irrigation, and industrial uses; natural seepage into lakes and streams; loss to evapotranspiration; and downward movement into underlying aquifers. Natural seepage and evapotranspiration are the principal means of discharge, since shallow wells account for only small amounts of water lost from the system, and the underlying Cooper Formation inhibits downward leakage where it occurs. However, downward leakage is a significant means of discharge where the Cooper is absent and the shallow system is underlain by the Santee Limestone and Black Mingo. As shown in Figure 28, water levels in shallow wells and Black Mingo wells near St. Stephen have a similar response to rainfall. Water levels in well 18W-a7 are slighly higher than in Black Mingo well 18W-a6, indicating that the shallow water has some head and can move downward. The sharp decline during 1980 and 1981 is the result of dewatering during construction of a power plant at the Santee River rediversional canal.

Shallow wells are used in all parts of the study area, but they are most common in Charleston County where the shallow system is thickest and most permeable and where water quality in the underlying formations is poor. In much of the area near the coast and south of Mt. Pleasant,

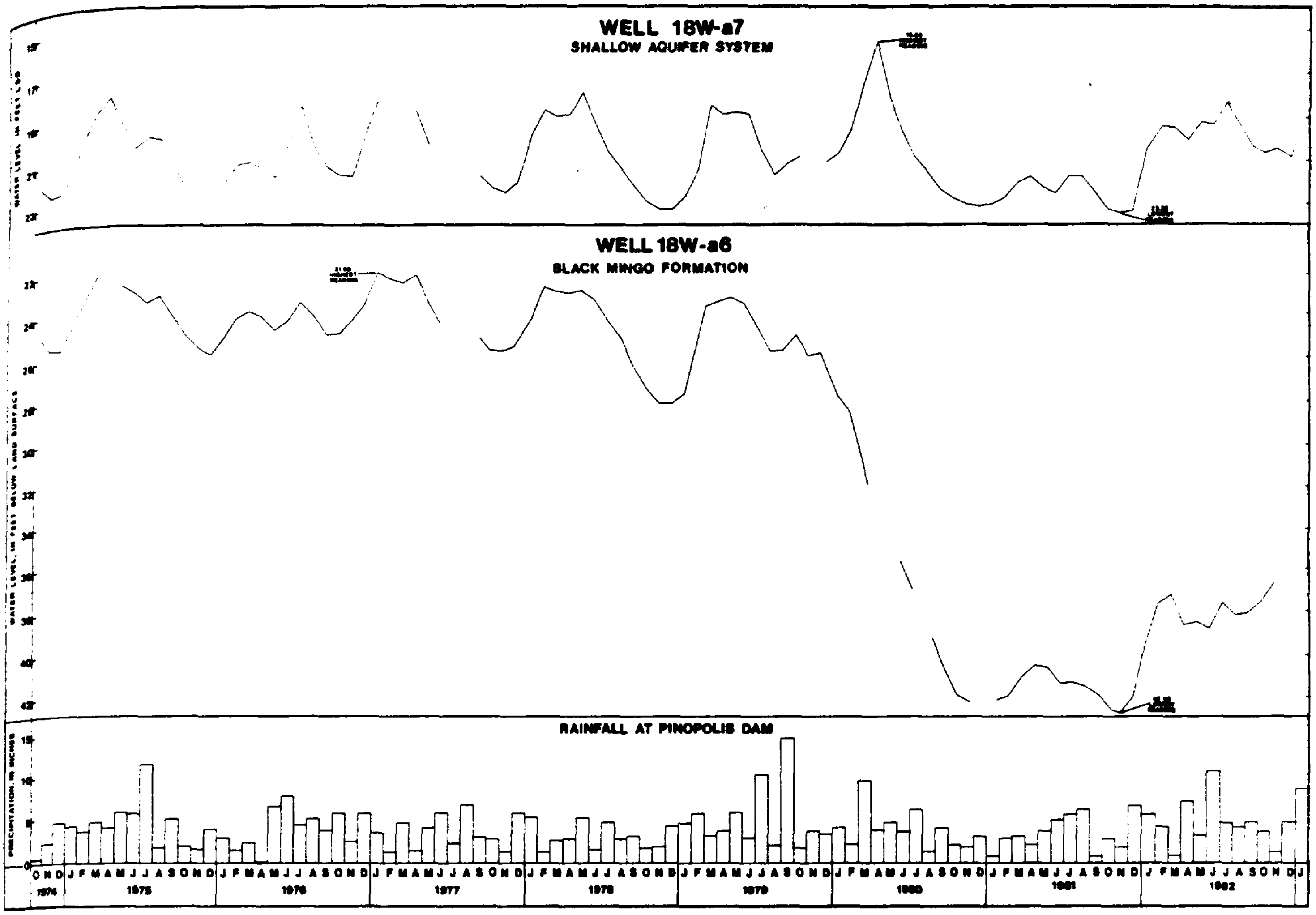

Figure 28. Hydrograph of observation wells 18W-a6 and 18W-a7, near St. Stephen.

the shallow system is the only economical source of fresh ground water for domestic users. The shallow system also supplies small public water systems and is used at Mt. Pleasant, Isle of Palms, Sullivans Island, and Edisto Beach to dilute high-fluoride water from the Black Creek Formation or Santee Limestone.

Although at least 10 gpm can be obtained from the shallow aquifers in nearly all parts of Charleston County, the same is not true for Berkeley and Dorchester Counties. Locally, the shallow sand beds are thin or contain high percentages of clay and silt. Consequently, wells must be drilled into the Santee Limestone and Black Mingo aquifers. The limestone is also a preferred source of ground water in its outcrop areas, where an open-hole well in the limestone may be constructed as economically as a shallow, screened well.

The thickness and permeability of the shallow aquifers vary greatly, even within a small area, so the quantity of water produced by individual wells is likewise variable. Small-diameter domestic wells are usually equipped with jet pumps of less than 1 horsepower and produce about 8 gpm. Most municipal and industrial wells are 4 to 6 inches in diameter, have 15 to 30 ft of screen, and yield between 20 and 200 gpm. In a typical well field, such as those maintained by the Town of Mt. Pleasant, individual well yields range from 40 gpm, with a specific capacity of 1.3 gpm/ft, to175 gpm, with a specific capacity of 7 gpm/ft. Municipal well fields located on the barrier islands use 15- to 20-ft deep well-point systems which spread withdrawals over large areas but restrict the depth of pumping in order to avoid saltwater intrusion or upconing.

The transmissivities of the shallow aquifers are assumed to be relatively low since the system averages less than 40 ft in thickness, commonly consists of fine-grained or poorly sorted sand, and reported specific capacities are generally less than 4 gpm/ft. An aquifer test at Edisto Island indicated a transmissivity of about 600 ft^2/day (J.T. Johnson, 1981). The saturated thickness of the aquifer was 45 ft, indicating a hydraulic conductivity of 13 ft/day. Discharge during the test was 32 gpm and water-level measurements were taken in the pumping well and two observation wells over a period of 30 hours.

WATER USE

The 1980 water use information presented in Table 3 was assembled from the files of the SCWRC and represents data collected as part of a statewide cooperative program with the U.S. Geological Survey. Table 4 represents the projected use of both ground water and surface water by six categories of water users. Information on water use by public supply systems was obtained through the assistance of the S.C. Department of Health and Environmental Control. Agricultural use was obtained through agents of the U.S. Soil Conservation Service and the Clemson University Extension Service. Industrial water-use figures were obtained through the U.S. Department of Labor, which included SCWRC water-use questionnaires in its annual review of labor statistics. Water use by private households was determined on the basis of the number of persons who were not served by public water supply systems. The amounts of water used to generate electricity were obtained directly from the generation plants.

Public-supply water usage constitutes the second largest category of water use. Most of that water (65.7 mgd) was withdrawn from the Edisto River Basin and transferred into the Ashley and Cooper River Basins by the Charleston Commission of Public Works. About 33 percent of the water was distributed directly to private households; 1 mgd of raw water was sold to the Town of Summerville, which mixes surface water with water from wells tapping Middendorf and Black Creek aquifers; and the remaining water, both raw and treated, was sold to commercial and industrial concerns. Public-supply surface-water use is projected to increase by 44 percent between 1980 and 2000.

Fourteen public water systems were supplied by wells in 1980. These systems withdrew a total of 4.8 mgd in 1980 and are expected to be withdrawing more than 10 mgd by 2000. Withdrawals by Mt. Pleasant, Moncks Corner, Summerville, and Berkeley County Water and Sewer Authority constitute the bulk of public-supply ground-water use.

Rural domestic water users pumped an average of 8.6 mgd from ground water sources, and this use category represents the greatest amount of ground water withdrawal in the study area. Domestic water users are defined as rural and suburban homes not served by public water-supply systems and represent about 25 percent of the area's population. The domestic water use was computed by multiplying average daily per capita use (80 gpd) by the population not served by public water systems (107,153). Ground water use by this category is expected to remain relatively high, increasing by 92 percent to 16.5 mgd, by 2000.

Self-supplied industry used 17.2 mgd, 5.3 mgd of which was obtained from wells. Projected industrial ground water use for 2000 is 6.7 mgd.

Water use by farms in the area is relatively insignificant. The total amount of water used for livestock and irrigation was less than 1 mgd in 1980 and is projected to rise to only 3.2 mgd by 2000. About 70 percent of that increase, or 2.2 mgd, will be used for irrigation. Less than 800 acres of farmland were irrigated in 1980.

By far the largest withdrawals are made by thermoelectric power plants. Three plants withdrew a total of 372 mgd of surface water, of which 16 mgd was saline surface water. projected withdrawals for 2000 are 432 mgd. Nonwithdrawal use for hydroelectric power generation is not given in Table 3, but it averaged 10,000 mgd in 1980.

Table 3. Average water use, 1980, in million gallons per day.

COUNTY	MUNICIPAL	DOMESTIC	INDUSTRIAL	LIVESTOCK	IRRIGATION (ACRES)	THERMO-ELECTRIC	TOTAL
BERKELEY							
Ground water	0.834	5.572	2.245	0.040	0.130 (175)	—	8.821
Surface water	—	—	10.181	.050	.156 (210)	356.000	366.387
Total	.834	5.572	12.426	.090	.286 (385)	356.000	375.208
CHARLESTON							
Ground water	2.116	1.239	.844	.030	.222 (300)	—	4.451
Surface water	65.664	—	.018	.020	—	16.000 (saline)	81.702
Total	67.780	1.239	.862	.050	.222 (300)	16.000	86.153
DORCHESTER							
Ground water	1.772	1.760	2.236	.060	—	—	5.828
Surface water	—	—	1.710	.060	.060 (80)	—	1.830
Total	1.772	1.760	3.946	.120	.060 (80)	—	7.658
TOTAL							
Ground water	4.772	8.571	5.325	.130	.352 (475)	—	19.100
Surface water	65.664	—	11.909	.130	.216 (290)	372.000	449.919
Total	70.386	8.571	17.234	.260	.567 (765)	372.000	469.019

NUS CORPORATION AND SUBSIDI/ Reference No. 5 **ON NOTE**

CONTROL NO:	DATE:	TIME:
	September 23., 1987	0900

DISTRIBUTION:

Plant Site File

BETWEEN:	OF:	PHONE:
Harvey Wilkins	South Carolina Dept. of Health	(803) 554-5533

AND:

Carol Doran NUS Corporation CAD 10-1-87

DISCUSSION:

Summerville Water System

Summerville gets their water from both surface and groundwater sources. Summerville has a surface water treatment plant that gets its water from the Edisto River. Summerville also has 4 deep wells and is currently drilling a 5th well. Mr. Wilkins knows that the wells are at least 1000 feet deep or greater but does not know exact depth or location of these wells. Summerville also gets some water from the city of Charleston.

Additionally, the Dorchester County Water Authority has several groundwater well systems in the area.

ACTION ITEMS:

OVERSIZED

DOCUMENT

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
SC	D061525192

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site)	02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER
Plant Site (Exxon Chemical Co.)	Highway 78 W.

03 CITY	04 STATE	05 ZIP CODE	06 COUNTY	07 COUNTY CODE	08 CONG DIST
Summerville	SC	29483	Dorchester	035	01

09 COORDINATES LATITUDE 33 01 06. LONGITUDE 80 10 42.

10 DIRECTIONS TO SITE (Starting from nearest public road)

III. RESPONSIBLE PARTIES

01 OWNER (If known)	02 STREET (Business, mailing, residential)
Exxon Chemical Company	

03 CITY	04 STATE	05 ZIP CODE	06 TELEPHONE NUMBER
			( )

07 OPERATOR (If known and different from owner)	08 STREET (Business, mailing, residential)

09 CITY	10 STATE	11 ZIP CODE	12 TELEPHONE NUMBER
			( )

13 TYPE OF OWNERSHIP (Check one)
☒ A. PRIVATE ☐ B. FEDERAL: ______ (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL
☐ F. OTHER: ______ (Specify) ☐ G. UNKNOWN

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)
☐ A. RCRA 3001 DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☐ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED: __/__/__ (MONTH DAY YEAR) ☒ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION
☐ YES DATE __/__/__ (MONTH DAY YEAR)
☒ NO

BY (Check all that apply)
☐ A. EPA ☐ B. EPA CONTRACTOR ☐ C. STATE ☐ D. OTHER CONTRACTOR
☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER: ______ (Specify)
CONTRACTOR NAME(S): ______

02 SITE STATUS (Check one)
☐ A. ACTIVE ☒ B. INACTIVE ☐ C. UNKNOWN

03 YEARS OF OPERATION
______ BEGINNING YEAR | ENDING YEAR ☒ UNKNOWN

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

25,000 pounds of yarn buried on site. Trace amounts of cadmium and mercury in yarn.

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

None. Producible supplies of water come from deep aquifers overlain by 170 foot thick impermeable marl.

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)
☐ A. HIGH (Inspection required promptly) ☐ B. MEDIUM (Inspection required) ☐ C. LOW (Inspect on time available basis) ☒ D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)	03 TELEPHONE NUMBER
Scott Gardner	US EPA	(404) 347-2234

04 PERSON RESPONSIBLE FOR ASSESSMENT	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
Carol D. Northern		NUS Corp.	(404) 938-7710	8 4 87 (MONTH DAY YEAR)

EPA FORM 2070-12 (7-81)

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT PART 2 - WASTE INFORMATION

I. IDENTIFICATION

01 STATE: SC
02 SITE NUMBER: D061525192

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- X A. SOLID
- ☐ B. POWDER, FINES
- ☐ C. SLUDGE
- ☐ D. OTHER ______ (Specify)
- ☐ E. SLURRY
- ☐ F. LIQUID
- ☐ G. GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

- TONS 12.5
- CUBIC YARDS ______
- NO. OF DRUMS ______

03 WASTE CHARACTERISTICS (Check all that apply)

- X A. TOXIC
- ☐ B. CORROSIVE
- ☐ C. RADIOACTIVE
- ☐ D. PERSISTENT
- ☐ E. SOLUBLE
- ☐ F. INFECTIOUS
- ☐ G. FLAMMABLE
- ☐ H. IGNITABLE
- ☐ I. HIGHLY VOLATILE
- ☐ J. EXPLOSIVE
- ☐ K. REACTIVE
- ☐ L. INCOMPATIBLE
- ☐ M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			
OLW	OILY WASTE			
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
(MES)	HEAVY METALS			

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
MES	Cadmium				
MES	Mercury				

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

Preliminary Assessment dated 3/31/81
EPA File

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
SC	D061525192

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☐ A. GROUNDWATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ________) ☒ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

Wastes are buried so potential for groundwater contamination exists.

01 ☐ B. SURFACE WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

None

01 ☐ C. CONTAMINATION OF AIR — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ D. FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ E. DIRECT CONTACT — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ F. CONTAMINATION OF SOIL — 02 ☐ OBSERVED (DATE: ________) ☒ POTENTIAL ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: ________ (Acres) 04 NARRATIVE DESCRIPTION

Wastes containing trace amounts of cadmium and mercury were buried (1).

01 ☐ G. DRINKING WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

None. Surficial aquifer does not produce adequate supplies for domestic use. Deeper aquifers are overlain by 170 foot thick impermeable marl (4,5).

01 ☐ H. WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ I. POPULATION EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________ 04 NARRATIVE DESCRIPTION

N/A

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
SC	D061525192

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☐ J. DAMAGE TO FLORA 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

01 ☐ K. DAMAGE TO FAUNA 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (Include name(s) of species)

N/A

01 ☐ L. CONTAMINATION OF FOOD CHAIN 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

01 ☐ M. UNSTABLE CONTAINMENT OF WASTES (Spills/runoff/standing liquids/leaking drums) 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

Wastes are buried.

01 ☐ N. DAMAGE TO OFFSITE PROPERTY 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

None

III. TOTAL POPULATION POTENTIALLY AFFECTED: None

IV. COMMENTS

V. SOURCES OF INFORMATION (Cite specific references, e. g., state files, sample analysis, reports)

See attached Reference List.

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
SC	D061525192

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site)	Plant Site (Exxon Chemical Co.)
02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER	Highway 78 W.
03 CITY	Summerville
04 STATE	SC
05 ZIP CODE	29483
06 COUNTY	Dorchester
07 COUNTY CODE	035
08 CONG DIST	01
09 COORDINATES LATITUDE	33 01 06.
LONGITUDE	80 10 42.
10 DIRECTIONS TO SITE (Starting from nearest public road)	

III. RESPONSIBLE PARTIES

01 OWNER (If known)	Exxon Chemical Company
02 STREET (Business, mailing, residential)	
03 CITY	
04 STATE	
05 ZIP CODE	
06 TELEPHONE NUMBER	( )
07 OPERATOR (If known and different from owner)	
08 STREET (Business, mailing, residential)	
09 CITY	
10 STATE	
11 ZIP CODE	
12 TELEPHONE NUMBER	( )

13 TYPE OF OWNERSHIP (Check one)

☒ A. PRIVATE ☐ B. FEDERAL: ______ (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL

☐ F. OTHER: ______ (Specify) ☐ G. UNKNOWN

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)

☐ A. RCRA 3001 DATE RECEIVED: __/__/__ MONTH DAY YEAR ☐ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED: __/__/__ MONTH DAY YEAR ☒ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION

☐ YES DATE __/__/__ MONTH DAY YEAR

☒ NO

BY (Check all that apply) ☐ A. EPA ☐ B. EPA CONTRACTOR ☐ C. STATE ☐ D. OTHER CONTRACTOR ☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER: ______ (Specify)

CONTRACTOR NAME(S): ______

02 SITE STATUS (Check one) ☐ A. ACTIVE ☒ B. INACTIVE ☐ C. UNKNOWN

03 YEARS OF OPERATION ______ BEGINNING YEAR ______ ENDING YEAR ☒ UNKNOWN

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED

25,000 pounds of yarn buried on site. Trace amounts of cadmium and mercury in yarn.

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION

None. Producible supplies of water come from deep aquifers overlain by 170 foot thick impermeable marl.

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)

☐ A. HIGH (Inspection required promptly) ☐ B. MEDIUM (Inspection required) ☐ C. LOW (Inspect on time available basis) ☒ D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	Scott Gardner
02 OF (Agency/Organization)	US EPA
03 TELEPHONE NUMBER	(404) 347-2234
04 PERSON RESPONSIBLE FOR ASSESSMENT	Carol D. Northern
05 AGENCY	
06 ORGANIZATION	NUS Corp.
07 TELEPHONE NUMBER	(404) 938-7710
08 DATE (MONTH DAY YEAR)	8 4 87

EPA FORM 2070-12 (7-81)

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
SC	D061525192

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- X A. SOLID
- ☐ B. POWDER, FINES
- ☐ C. SLUDGE
- ☐ D. OTHER ______ (Specify)
- ☐ E. SLURRY
- ☐ F. LIQUID
- ☐ G. GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

- TONS 12.5
- CUBIC YARDS ______
- NO. OF DRUMS ______

03 WASTE CHARACTERISTICS (Check all that apply)

- X A. TOXIC
- ☐ B. CORROSIVE
- ☐ C. RADIOACTIVE
- ☐ D. PERSISTENT
- ☐ E. SOLUBLE
- ☐ F. INFECTIOUS
- ☐ G. FLAMMABLE
- ☐ H. IGNITABLE
- ☐ I. HIGHLY VOLATILE
- ☐ J. EXPLOSIVE
- ☐ K. REACTIVE
- ☐ L. INCOMPATIBLE
- ☐ M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			
OLW	OILY WASTE			
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS			

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
MES	Cadmium				
MES	Mercury				

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

Preliminary Assessment dated 3/31/81
EPA File

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
SC	D061525192

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☐ A. GROUNDWATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ______) ☒ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

Wastes are buried so potential for groundwater contamination exists.

01 ☐ B. SURFACE WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

None

01 ☐ C. CONTAMINATION OF AIR — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ D. FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ E. DIRECT CONTACT — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ F. CONTAMINATION OF SOIL — 02 ☐ OBSERVED (DATE: ______) ☒ POTENTIAL ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: ______ (Acres) 04 NARRATIVE DESCRIPTION

Wastes containing trace amounts of cadmium and mercury were buried (1).

01 ☐ G. DRINKING WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

None. Surficial aquifer does not produce adequate supplies for domestic use. Deeper aquifers are overlain by 170 foot thick impermeable marl (4,5).

01 ☐ H. WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

N/A

01 ☐ I. POPULATION EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______ 04 NARRATIVE DESCRIPTION

N/A

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

EPA

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER
SC	D061525192

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☐ J. DAMAGE TO FLORA — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

01 ☐ K. DAMAGE TO FAUNA — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (include name(s) of species)

N/A

01 ☐ L. CONTAMINATION OF FOOD CHAIN — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

01 ☐ M. UNSTABLE CONTAINMENT OF WASTES (Spills/runoff/standing liquids/leaking drums) — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

Wastes are buried.

01 ☐ N. DAMAGE TO OFFSITE PROPERTY — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

None

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING — 02 ☐ OBSERVED (DATE: ______) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

N/A

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

None

III. TOTAL POPULATION POTENTIALLY AFFECTED: None

IV. COMMENTS

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

See attached Reference List.

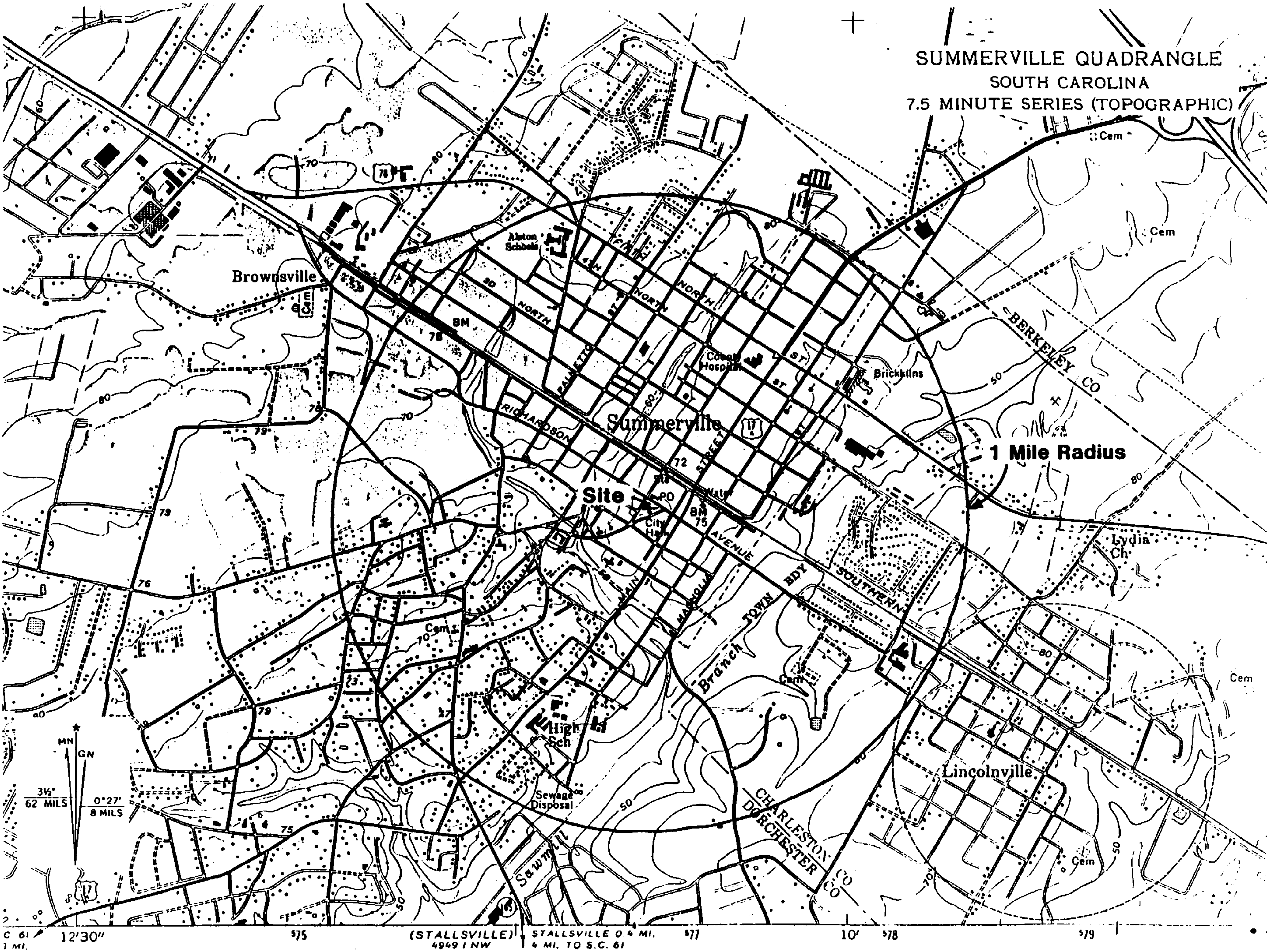
SUMMERVILLE QUADRANGLE
SOUTH CAROLINA
7.5 MINUTE SERIES (TOPOGRAPHIC)
Brownsville
Alston Schools
County Hospital
Brickkilns
Summerville
1 Mile Radius
Site
PO
City Hall
Water
High Sch
Sewage Disposal
Lydia Ch
Lincolnville
Cem
BERKELEY CO
CHARLESTON CO
DORCHESTER CO
SOUTHERN
TOWN BDY
Branch
Sawmill
RICHARDSON
NORTH
MAIN
MAGNOLIA
AVENUE
STREET
PALMETTO
MN
GN
3½°
62 MILS
0°27'
8 MILS
12'30"
575
577
10'
578
579
(STALLSVILLE)
4949 I NW
STALLSVILLE 0.4 MI.
4 MI. TO S.C. 61
SCALE 1:24000

Figure 1

REGION: 04
STATE : SC

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF EMERGENCY AND REMEDIAL RESPONSE
C E R C L I S V 1.2

RUN DATE: 06/30/87
RUN TIME: 12:01:11

M.2 - SITE MAINTENANCE FORM

* ACTION: _ *

EPA ID : SCD061525192

SITE NAME: PLANT SITE SOURCE: S * ________ _ *

STREET : HWY 78 W CONG DIST: 01 * ________ __ *

CITY : SUMMERVILLE ZIP: 29483 * ________ _____-____ *

CNTY NAME: DORCHESTER CNTY CODE : 035 * ________ ___ *

LATITUDE : 33/01/06.0 LONGITUDE : 080/10/42.0 * __/__/__._ ___/__/__._ *

LL-SOURCE: R LL-ACCURACY: * _ _ *

SMSA : 1440 HYDRO UNIT: 03050202 * ____ ________ *

INVENTORY IND: Y REMEDIAL IND: Y REMOVAL IND: N FED FAC IND: N * _ _ _ _ *

NPL IND: N NPL LISTING DATE: NPL DELISTING DATE: * _ __/__ __/__ *

SITE/SPILL IDS: * __ __ __ __ __ *

RPM NAME: RPM PHONE: - - * ________ ___-___-____ *

SITE CLASSIFICATION: SITE APPROACH: * __ ___ *

DIOXIN TIER: REG FLD1: REG FLD2: * ____ _____ _ *

RESP TERM: PENDING ( ) NO FURTHER ACTION ( ) * PENDING (_) NO FURTHER ACTION (_) *

ENF DISP: NO VIABLE RESP PARTY ( ) VOLUNTARY RESPONSE ( ) * _ _ *
ENFORCED RESPONSE ( ) COST RECOVERY ( ) * _ _ *

SITE DESCRIPTION:

* ________ *
* ________ *
* ________ *
* ________ *

SD

NEED

M.2 - PROGRAM MAINTENANCE FORM

* ACTION: _ *

SITE: PLANT SITE

EPA ID: SCD061525192 PROGRAM CODE: H01 PROGRAM TYPE: * _ *

PROGRAM QUALIFIER: ALIAS LINK : * ___ _ *

PROGRAM NAME: SITE EVALUATION * ______________________________ *

DESCRIPTION:

* ____ *

* ____ *

* ____ *

* ____ *

M.2 - EVENT MAINTENANCE FORM

* ACTION: _ *

SITE: PLANT SITE
PROGRAM: SITE EVALUATION

EPA ID: SCD061525192 PROGRAM CODE: H01 EVENT TYPE: DS1

FMS CODE: EVENT QUALIFIER : EVENT LEAD: E * _ ___ _ *

EVENT NAME: DISCOVERY STATUS: * ______________________________ _ *

DESCRIPTION:

* ____ *
* ____ *
* ____ *
* ____ *

ORIGINAL	CURRENT	ACTUAL				
START:	START:	START:	* __/__/__	__/__/__	__/__/__	*
COMP :	COMP :	COMP : 11/01/79	* __/__/__	__/__/__	__/__/__	*

HQ COMMENT:

* ____ *

RG COMMENT:

* ____ *

COOP AGR #	AMENDMENT #	STATUS	STATE %					
			0	* __________	__________	__	___	*

Mr. Nichols ~~Mr. Mattler~~ 873-5800

POTENTIAL HAZARDOUS WASTE SITE IDENTIFICATION AND PRELIMINARY ASSESSMENT

REGION | SITE NUMBER (to be assigned by Hq) 2695

NOTE: This form is completed for each potential hazardous waste site to help set priorities for site inspection. The information submitted on this form is based on available records and may be updated on subsequent forms as a result of additional inquiries and on-site inspections.

GENERAL INSTRUCTIONS: Complete Sections I and III through X as completely as possible before Section II (Preliminary Assessment). File this form in the Regional Hazardous Waste Log File and submit a copy to: U.S. Environmental Protection Agency; Site Tracking System; Hazardous Waste Enforcement Task Force (EN-335); 401 M St., SW; Washington, DC 20460.

I. SITE IDENTIFICATION

A. SITE NAME: EXXON CHEMICAL COMPANY (PLANT SITE)

B. STREET (or other identifier): HWY 78 W

C. CITY: SUMMERVILLE

D. STATE: SC

E. ZIP CODE: 29483

F. COUNTY NAME: Dorchester

G. OWNER/OPERATOR (if known)

1. NAME: Same as above

2. TELEPHONE NUMBER: 873-5800

H. TYPE OF OWNERSHIP

☐ 1. FEDERAL ☐ 2. STATE ☐ 3. COUNTY ☐ 4. MUNICIPAL ☒ 5. PRIVATE ☐ 6. UNKNOWN

I. SITE DESCRIPTION

a hole was dug & waste put in it

J. HOW IDENTIFIED (i.e., citizen's complaints, OSHA citations, etc.)

K. DATE IDENTIFIED (mo., day, & yr.)

L. PRINCIPAL STATE CONTACT

1. NAME: John D. Ahlert

2. TELEPHONE NUMBER: 722-2962

II. PRELIMINARY ASSESSMENT (complete this section last)

A. APPARENT SERIOUSNESS OF PROBLEM

☐ 1. HIGH ☐ 2. MEDIUM ☐ 3. LOW ☐ 4. NONE ☒ 5. UNKNOWN

See Page 4

B. RECOMMENDATION

☐ 1. NO ACTION NEEDED (no hazard)

☐ 2. IMMEDIATE SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 3. SITE INSPECTION NEEDED
a. TENTATIVELY SCHEDULED FOR:
b. WILL BE PERFORMED BY:

☐ 4. SITE INSPECTION NEEDED (low priority)

C. PREPARER INFORMATION

1. NAME: John D. Ahlert

2. TELEPHONE NUMBER: 722-2962

3. DATE (mo., day, & yr.): 3/31/81

III. SITE INFORMATION

A. SITE STATUS

☐ 1. ACTIVE (Those industrial or municipal sites which are being used for waste treatment, storage, or disposal on a continuing basis, even if infrequently.)

☒ 2. INACTIVE (Those sites which no longer receive wastes.)

☐ 3. OTHER (specify): (Those sites that include such incidents like "midnight dumping" where no regular or continuing use of the site for waste disposal has occurred.)

B. IS GENERATOR ON SITE?

☐ 1. NO ☐ 2. YES (specify generator's four-digit SIC Code):

C. AREA OF SITE (in acres)

D. IF APPARENT SERIOUSNESS OF SITE IS HIGH, SPECIFY COORDINATES

1. LATITUDE (deg.-min.-sec.)

2. LONGITUDE (deg.-min.-sec.)

E. ARE THERE BUILDINGS ON THE SITE?

☐ 1. NO ☐ 2. YES (specify):

T2070-2 (10-79)

Continue On Reverse

Continued From Front

IV. CHARACTERIZATION OF SITE ACTIVITY

Indicate the major site activity(*ies*) and details relating to each activity by marking 'X' in the appropriate boxes.

'X'	A. TRANSPORTER	X	B. STORER	X	C. TREATER	'X'	D. DISPOSER
	1. RAIL		1. PILE		1. FILTRATION		1. LANDFILL
	2. SHIP		2. SURFACE IMPOUNDMENT		2. INCINERATION		2. LANDFARM
	3. BARGE		3. DRUMS		3. VOLUME REDUCTION		3. OPEN DUMP
	4. TRUCK		4. TANK, ABOVE GROUND		4. RECYCLING/RECOVERY		4. SURFACE IMPOUNDMENT
	5. PIPELINE		5. TANK, BELOW GROUND		5. CHEM./PHYS. TREATMENT		5. MIDNIGHT DUMPING
	6. OTHER (*specify*):		6. OTHER (*specify*):		6. BIOLOGICAL TREATMENT		6. INCINERATION
					7. WASTE OIL REPROCESSING		7. UNDERGROUND INJECTION
					8. SOLVENT RECOVERY		8. OTHER (*specify*): over [illegible] are the dump
					9. OTHER (*specify*):		

E. SPECIFY DETAILS OF SITE ACTIVITIES AS NEEDED

V. WASTE RELATED INFORMATION

A. WASTE TYPE

- [ ] 1 UNKNOWN
- [ ] 2 LIQUID
- [x] 3. SOLID
- [ ] 4. SLUDGE
- [ ] 5. GAS

B. WASTE CHARACTERISTICS

- [ ] 1 UNKNOWN
- [ ] 2. CORROSIVE
- [ ] 3. IGNITABLE
- [ ] 4 RADIOACTIVE
- [ ] 5 HIGHLY VOLATILE
- [ ] 6. TOXIC
- [ ] 7 REACTIVE
- [x] 8 INERT
- [ ] 9 FLAMMABLE
- [ ] 10. OTHER (*specify*):

C. WASTE CATEGORIES

1. Are records of wastes available? Specify items such as manifests, inventories, etc. below.

2. Estimate the amount (*specify unit of measure*) of waste by category; mark 'X' to indicate which wastes are present.

a. SLUDGE	b. OIL	c. SOLVENTS	d. CHEMICALS	e. SOLIDS	f. OTHER
AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT	AMOUNT
UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE	UNIT OF MEASURE
'X' (1) PAINT, PIGMENTS	'X' (1) OILY WASTES	'X' (1) HALOGENATED SOLVENTS	'X' (1) ACIDS	'X' (1) FLYASH	'X' (1) LABORATORY PHARMACEUT.
(2) METALS SLUDGES	(2) OTHER (*specify*):	(2) NON-HALOGNTD. SOLVENTS	(2) PICKLING LIQUORS	(2) ASBESTOS	(2) HOSPITAL
(3) POTW		(3) OTHER (*specify*):	(3) CAUSTICS	(3) MILLING/ MINE TAILINGS	(3) RADIOACTIVE
(4) ALUMINUM SLUDGE			(4) PESTICIDES	(4) FERROUS SMLTG. WASTES	(4) MUNICIPAL
(5) OTHER (*specify*):			(5) DYES/INKS	(5) NON-FERROUS SMLTG. WASTES	(5) OTHER (*specify*):
			(6) CYANIDE	(6) OTHER (*specify*):	
			(7) PHENOLS		
			(8) HALOGENS		
			(9) PCB		
			(10) METALS		
			(11) OTHER (*specify*)		

 Continue On Page 3

Continued From Page 2

V. WASTE RELATED INFORMATION (continued)

3. LIST SUBSTANCES OF GREATEST CONCERN WHICH MAY BE ON THE SITE (place in descending order of hazard).

4. ADDITIONAL COMMENTS OR NARRATIVE DESCRIPTION OF SITUATION KNOWN OR REPORTED TO EXIST AT THE SITE.

VI. HAZARD DESCRIPTION

A. TYPE OF HAZARD	B. POTENTIAL HAZARD (mark 'X')	C. ALLEGED INCIDENT (mark 'X')	D. DATE OF INCIDENT (mo.,day,yr.)	E. REMARKS
1. NO HAZARD				
2. HUMAN HEALTH				
3. NON-WORKER INJURY/EXPOSURE				
4. WORKER INJURY				
5. CONTAMINATION OF WATER SUPPLY				
6. CONTAMINATION OF FOOD CHAIN				
7. CONTAMINATION OF GROUND WATER				
8. CONTAMINATION OF SURFACE WATER				
9. DAMAGE TO FLORA/FAUNA				
10. FISH KILL				
11. CONTAMINATION OF AIR				
12. NOTICEABLE ODORS				
13. CONTAMINATION OF SOIL				
14. PROPERTY DAMAGE				
15. FIRE OR EXPLOSION				
16. SPILLS/LEAKING CONTAINERS/ RUNOFF/STANDING LIQUIDS				
17. SEWER, STORM DRAIN PROBLEMS				
18. EROSION PROBLEMS				
19. INADEQUATE SECURITY				
20. INCOMPATIBLE WASTES				
21. MIDNIGHT DUMPING				
22. OTHER (specify):				

 Continue On Reverse

Continued From Front

VII. PERMIT INFORMATION

A. INDICATE ALL APPLICABLE PERMITS HELD BY THE SITE.

☐ 1. NPDES PERMIT ☐ 2. SPCC PLAN ☐ 3. STATE PERMIT *(specify)*: ______

☐ 4. AIR PERMITS ☐ 5. LOCAL PERMIT ☐ 6. RCRA TRANSPORTER

☐ 7. RCRA STORER ☐ 8. RCRA TREATER ☐ 9. RCRA DISPOSER

☐ 10. OTHER *(specify)*: ______

B. IN COMPLIANCE?

☐ 1. YES ☐ 2. NO ☐ 3. UNKNOWN

4. WITH RESPECT TO *(list regulation name & number)*: ______

VIII. PAST REGULATORY ACTIONS

☐ A. NONE ☐ B. YES *(summarize below)*

IX. INSPECTION ACTIVITY *(past or on-going)*

☐ A. NONE ☐ B. YES *(complete items 1,2,3, & 4 below)*

1. TYPE OF ACTIVITY	2. DATE OF PAST ACTION *(mo., day, & yr.)*	3. PERFORMED BY: *(EPA/State)*	4. DESCRIPTION

X. REMEDIAL ACTIVITY *(past or on-going)*

☐ A. NONE ☐ B. YES *(complete items 1, 2, 3, & 4 below)*

1. TYPE OF ACTIVITY	2. DATE OF PAST ACTION *(mo., day, & yr.)*	3. PERFORMED BY: *(EPA/State)*	4. DESCRIPTION

NOTE: Based on the information in Sections III through X, fill out the Preliminary Assessment *(Section II)* information on the first page of this form.

I spoke with Mr. Jim Nichols, Plant Engineer on 3/31/81. He stated that only on a one time basis they disposed of 25,000 pounds of yarn on the site and covered it with earth. A letter from Mr. Dick Swanson of Exxon to Mr. Charles Kelly confirms apparently that they had approval. A very small part of the yarn did have mercury and cadmium in it in trace amounts, however Mr. Nichols stated that "the poly substrate ties up these heavy metals when no sunlight hits them and the waste is buried." He also stated that it would be impossible to pull a representative sample because a large part of the waste had no mercury or cadmium.